AUTOMATION

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

This coil-fed Wean "Flying Press" line performs both shearing and blanking operations.

Massey-Ferguson saves up to $9 per ton on material costs with Wean coil processing lines

As a measure of its products' popularity, Massey-Ferguson, Ltd. of Toronto cites the fact that M-F combine and baler production fills every available Canadian railroad flat car twice a year.

Five years ago, Massey-Ferguson's production and purchasing personnel made a thorough cost study of their extensive steel demands, then being provided by shearing from purchased sheets. As a result, three Wean coil processing lines were installed to supply these requirements directly from standard coil.

The three Wean lines are: (1) an edge-trim and cut-to-length line, with a flying shear; (2) a Wean slitting line; and (3) a Wean "Flying Press" line that offers the versatility of straight or angle shearing or blanking of coil stock, all in one machine.

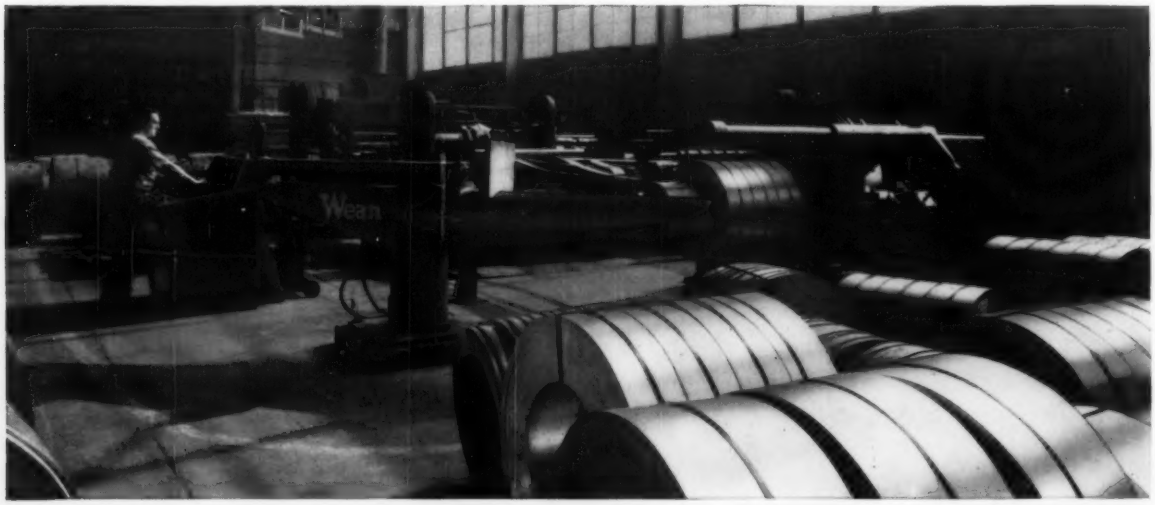
Massey-Ferguson management credits this coil processing system with savings of from $4-9 per ton of metal consumed. And besides the direct production savings in sheet supply, the threat of model-change obsolescence is removed when steel inventory is in coil form.

Many metalworking firms have had similar experience in the profit-making aspects of coil processing equipment. The concept and economics of coil processing are discussed in a new brochure available from Wean. Write for your copy of this informative catalog.

WEAN EQUIPMENT CORPORATION
22800 Lakeland Boulevard
CLEVELAND 17, OHIO

WEAN

Standard coils are slit to a wide variety of widths on this Wean line at the Toronto M-F plant.



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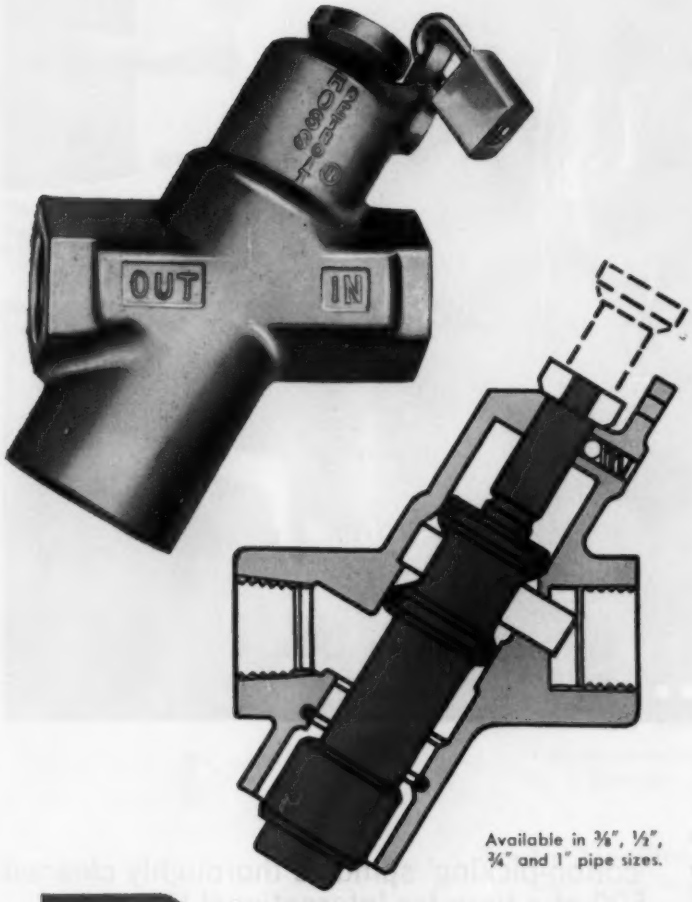
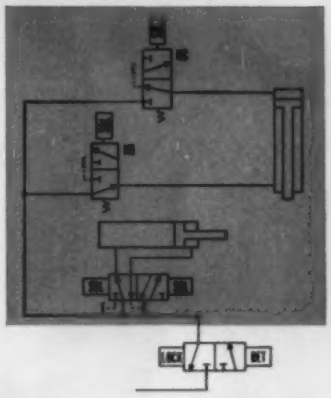
Lock out air for machine repair

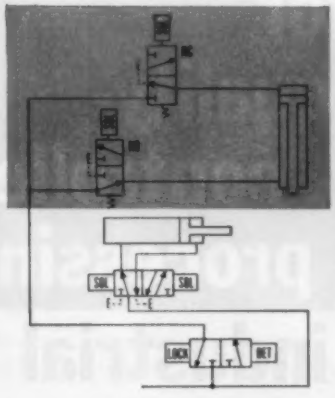


Available in ⅜", ½", ¾" and 1" pipe sizes.

(AIR LOCKED OUT FROM SHADED AREA OF CIRCUIT)



Use the L-O-X valve to shut down an entire air circuit...



...or use it to shut down just a portion of the circuit.

Ross L-O-X VALVE

(Lock—Out—eXhaust)

Now you can actually lock out air that operates a machine, as a safeguard when making machine repairs. The Ross L-O-X Valve installs in the supply line leading to the machine, upstream of any operating valve. It is so designed that when closed, supply-air to the machine is shut off and air downstream is exhausted. The valve can be *padlocked* in this position.

More L-O-X valves can be incorporated in the circuit to shut off and exhaust various segments of the circuit. Thus portions of the circuit can be available for maintenance service without shutting down the entire circuit. Detented in the open position, designed for very low pressure drop. Lightweight aluminum construction. Call your Ross representative or write for literature.

ROSS OPERATING VALVE COMPANY

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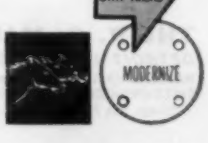

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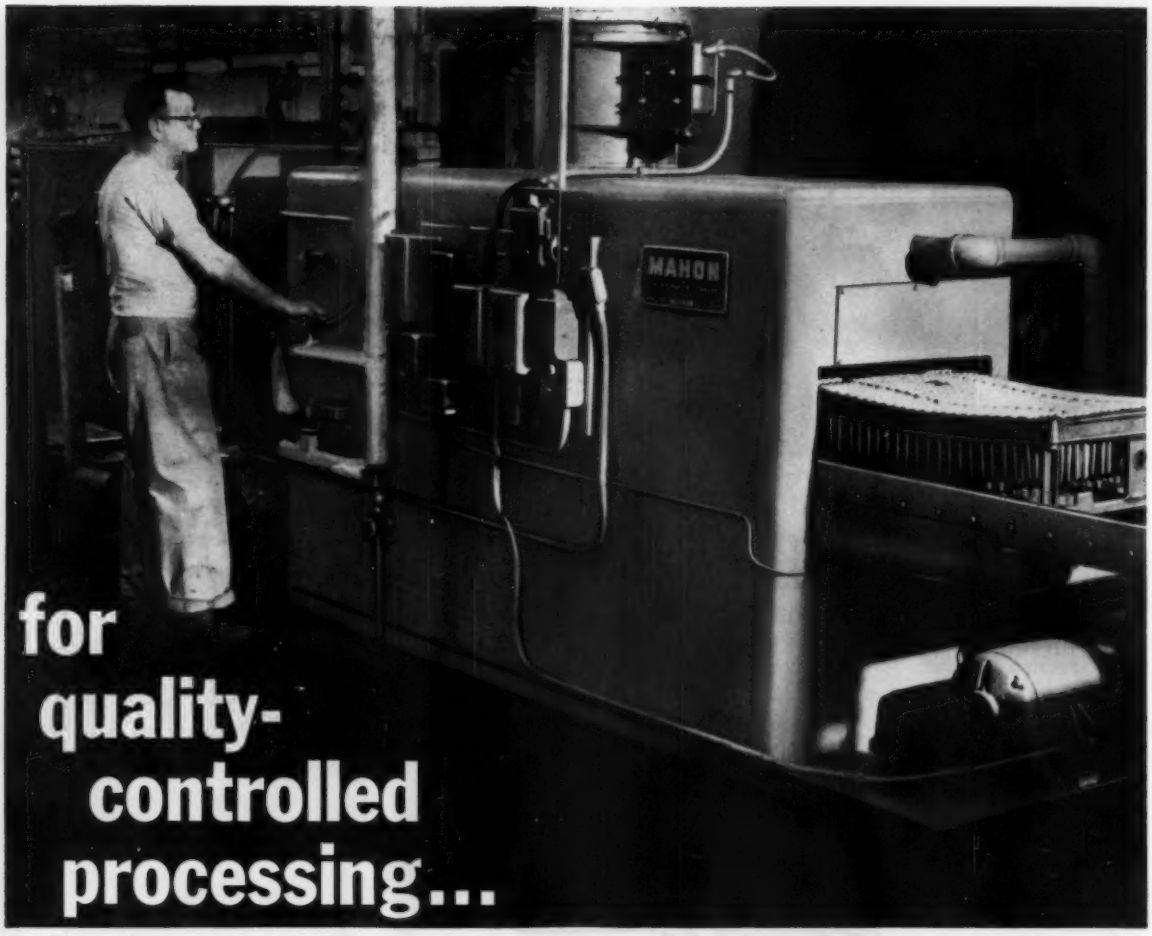
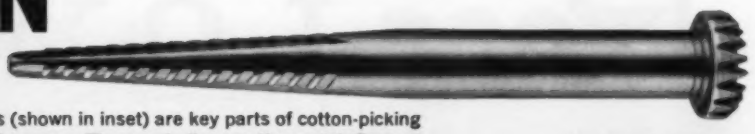


for quality-controlled processing... industrial equipment by MAHON

'cotton-picking' spindles thoroughly cleaned 500 at a time for International Harvester



Hardened, chromium-plated, barbed spindles (shown in inset) are key parts of cotton-picking machines made by International Harvester Company. These spindles are the metal 'fingers' that actually field-pick the cotton—several million are produced each year at IH's Memphis, Tenn., Works. A critical step in processing these parts is thorough cleaning before heat treating and plating. Removal of oil, grease, and foreign matter from the spindle surfaces is essential to insure uniform hardness . . . and long product life.

For **"quality-controlled processing"** the spindles are washed and dried in Mahon equipment. This special machine, developed for International Harvester from Mahon Industrial Equipment Division 'almost-standard' designs, means production efficiency . . . product quality . . . faster delivery and reasonable cost. Over the years Mahon equipment is your best investment. Call in a Mahon industrial engineer; let him prove why.

In cleaning a 500-piece-load of cotton-picking spindles, the two-stage Mahon machine washes the parts with detergent in hot water (at 180°F); then hot-air dries the load at (250°F). Automatic cycle time is about 15 minutes per load.

YOUR BIGGEST VALUE IS IN MAHON'S PLANNING & ENGINEERING EXPERIENCE

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MAHON

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automation outlook

BIGGEST NUMERICAL CONTROL FIELD

". . . I am convinced that there is actually a greater savings to be made by a point-to-point numerical control system. There will not be the fantastic savings per piece as has been shown by some of the large profile milling machines. But, because the initial cost is much less for the point-to-point system, it can be purchased and used by a much greater number of shops . . . ."—*S. J. Hunt, vice president, engineering, National Automatic Tool Co. Inc., see page 67.*

TAX INCENTIVES FOR RESEARCH

" . . . the federal government must give industry a reason—an incentive—to increase progressively its support of basic research. The National Science Foundation has recommended that serious consideration be given to the use of tax incentives for this purpose. . . . Among the incentives which have been proposed are a faster write-off of new research facilities; an outright tax credit for research contributions or expenditures; and a provision which permits an income tax write-off of more than 100 per cent of expenditures on scientific research facilities, similar to the 120 per cent write-off granted by the United Kingdom. . . ."—*M. W. Cresap Jr., president, Westinghouse Electric Corp.*

LOOK AT THE FOREST

". . . automation concepts are most properly applied when the complete system or process is considered. . . . Yet, it is often both reasonable and advisable that a part of a process be automated as long as the whole system has been studied and the solution for the part being implemented is compatible with prospective additions to the system. . . ."—*W. C. Leone, vice president and general manager, Electronics Div., Rheem Mfg. Co.*

PACKAGING IMPROVEMENTS

". . . Modern concepts point to two areas where improvements in packaging can be obtained: The application of automatic techniques to packaging equipment and the integration of the packaging line into plant operations . . . ."—*W. E. Wood, president, Processes Research Inc., see page 74.*

CHECK THE FORMS

". . . Very careful and detailed system studies encompassing the entire business operation . . . must be made before EDP can become fully effective. In fact, quite frequently industry has found that the greatest cumulative savings result from the improvements which can be made in their form-systems as a result of these studies, rather than just those realized by the greater speeds and capacities of EDP equipment . . . ."—*E. A. Touma, manager, vocational product studies, Moore Business Forms.*

AUTOMATIC CONTROL—TOP LEVEL PROBLEM

". . . The scope of automatic control problems is constantly widening and thus taking the problems and decisions higher and higher and therefore closer and closer to top management. Furthermore, the cost of solving these problems and the effect this has upon existing organization is requiring more and more the attention of top management. . . ."—*G. M. Muschamp, engineering vice president, Industrial Products Group, Minneapolis-Honeywell Regulator Co.*

AUTOMATION

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BPA NBP

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...Fluid Power news

REPORT NO. 12,107
HYTAC* **AIDS MAKING OF NEW EXTENSIBLE PAPER**

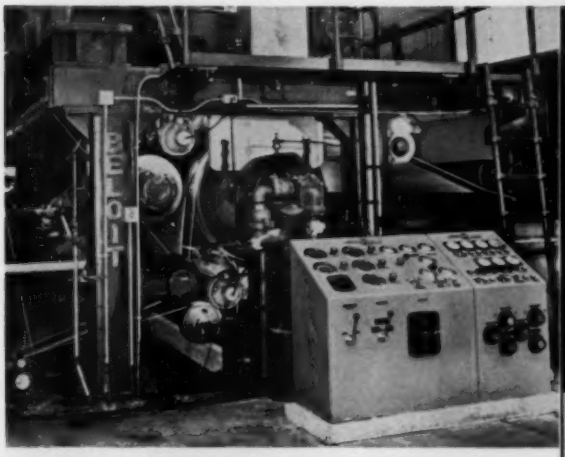
From Oilgear *Application-Engineering* Files

HOW *HYTAC** SYSTEMS CONTROL NEW EXTENSIBLE PAPER MACHINE SECTION SPEEDS IN 12 MILLS

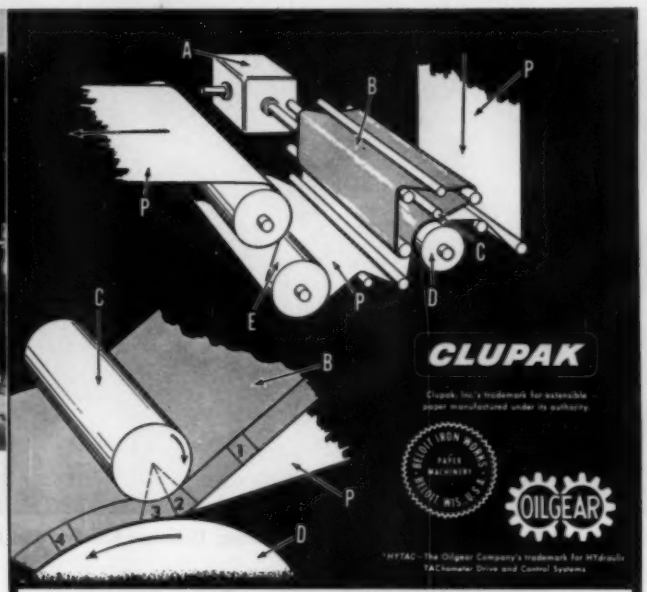
USERS: *Twelve Paper Companies—Licensed by CLUPAK, INC.*

Builder—Sections and Differential Drives—Beloit Iron Works, Beloit, Wisconsin

DATA: Systems to vary and precisely control speed and draw of new sections that can be an integral part of complete, new paper machines, or inserted into existing machines for production of CLUPAK® extensible paper—a revolutionary, patented, smooth, tough, kraft sheet. Original requirements called for systems that, when applied to *Beloit* mechanical differentials, would: *1.* Provide precision-controlled, infinitely variable section speed decrease up to 10% under main lineshaft speed—as selected from remote pushbutton stations. *2.* Maintain selected section speed within ±0.25% max. variation over a 50% load change at max. lineshaft speed. *3.* Be: compact; impervious to heat, high humidity; thrifty on electrical power input, wiring, installation downtime, floor space; completely free, if possible, from maintenance-provoking belts, chains, relays. *4.* Insure trouble-free, continuous, heavy-duty, full-production paper machine drive service—but permit section immobilization for production of non-extensible stock. *5.* One source and responsibility for these speed and draw controls preferred.



One of the most recent of the twelve new **Beloit** extensible sections and control consoles incorporating **HYTAC* SYSTEMS** for precise speed and draw control—as installed on No. 1 machine at **International Paper Company's Southern Kraft Division Mill, Camden, Arkansas,** to produce CLUPAK® extensible paper. Control console instrumentation includes direct-reading hydraulic pressure gages from the **OILGEAR System** to provide operators with constant, visual, exact indication of load or draw on the section.



HOW IT WORKS: Section driven by Oilgear-equipped **Beloit** differential (A), consists of a 1-in. thick natural rubber Blanket (B) operating over 3 rolls, and between Nip Roll (C) and steam-heated, polished, chrome plated Dryer Drum (D). Paper (P) is held between Blanket (B), slipping against Dryer Drum (D). Enlarged view at Nip Roll shows how normal (1) Blanket (B) is compressed (2), squeezed and elongated (3), and rapidly contracts (4) after leaving Nip Roll—shrinking paper. Normal production shrink requirement is accurately controllable up to 15% by controlled variation in nip pressure, moisture content, dryer drum temperature. Accurate control of draw in and between extensible unit and 3rd Dryer Section (E) is required regardless of load changes . . . a reason for the precise, infinitely variable speed-draw control provided by Application-Engineered **HYTAC* Systems.**

SOLUTION: Application-Engineered *HYTAC** (HY*draulic* TAC*hometer*) controlled differential drives consisting of Oilgear "DRt-3517" Variable Displacement Pumps, "H-6017" Constant Displacement Motors, and *HYTAC** components with remote pushbutton control to provide precise speed-draw control on *Beloit* extensible sections installed and commercially producing CLUPAK® extensible paper at nine mills in the United States, two in Canada, and one in Sweden. Several other paper manufacturers licensed by CLUPAK, Inc., to produce extensible paper under its authority, now have these Oilgear-equipped *Beloit* extensible sections on order. Oilgear *HYTAC** Drive-Control Systems were selected after 3 years of development on this process and machine—from a 2-in. table model, through a 15-in. laboratory model, and a 60-in. pilot model—as best suited to provide the accuracy and range of control required for the variable speed drives.

Actual commercial operation has proved that these highly accurate, compact, heavy-duty, Oilgear Systems can maintain any selected section speed with less than ±0.25% variation regardless of load change *over a 10:1 range of lineshaft rpm—plus enabling operators to infinitely vary each section's drive rpm up to 15% under main lineshaft rpm . . . exceeding originally specified requirements!*

Other inherent Oilgear "Any-Speed" Drive features are: cushioned, controlled starting, acceleration, deceleration, braking . . . positive, automatic overload protection . . . continuously filtered pressure and flood lubrication. Copies of Oilgear's *Fluid Power NEWS* 3, 5, 8, 9, 11—with detailed descriptions of some of these and other *Application-Proved* installations are available on request.

For practical solutions to your linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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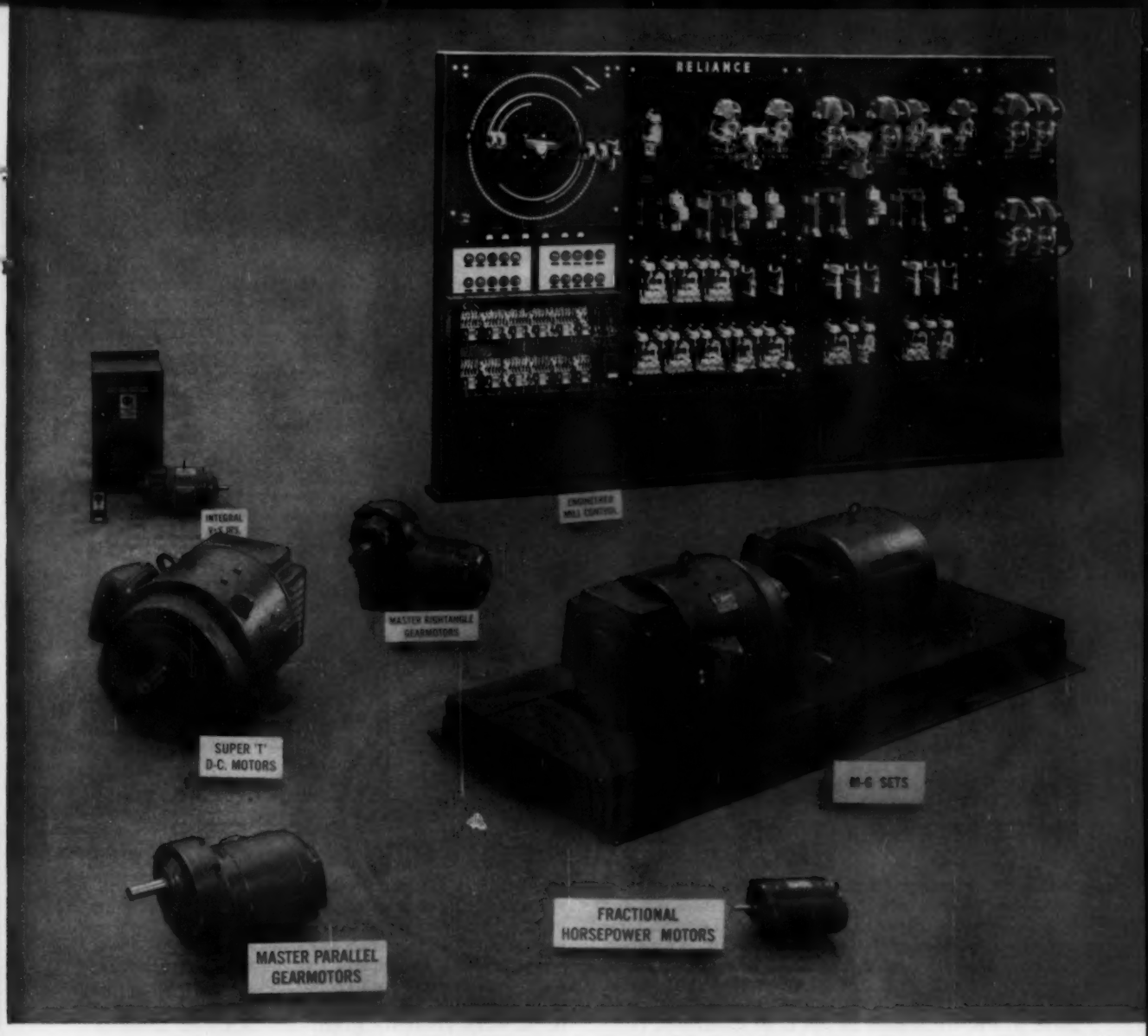

A-1067

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Circle 661 on Page 19

UPPER LEFT . . . Loaded train moves through doors that have automatically opened, and commences trip over 1400 feet of Monorail track.

Louden Monorail Interplant Transport System operates trouble free the year around. Three carriers make up train that travels completely unattended from storage area in one building to shipping area in another. Smooth operation of Monorail insures safe transportation of chinaware between plants.

LOWER RIGHT . . . Forklift trucks quickly unload train after it automatically stops at its destination. Carriers may be lowered and raised independently for greater handling ease.

CUT COSTS WITH MONORAIL INTERPLANT TRANSPORT

Companies grow, production facilities expand and interplant handling of materials, parts, semi-finished and finished products become complicated and costly. Time and again a Louden Monorail Interplant Transport System has proved to be the perfect answer. And with Louden's Selectomatic Control, transport is automatic.

A good example is The Louden Selectomatic Interplant Transport System at the Eljer Company, Division of The Murray Corporation, Ford City, Pennsylvania. Recently, to increase plant production, another plant was built similar to the original plant. Shipping and docking facilities for both plants were retained in the original building, only the storage area was incorporated in the second. Therefore, it became necessary to get stock from the second plant to the shipping dock in the first plant. 1400 feet of Louden Monorail with three steel carriers provide the perfect answer. The Louden MotoVeyor pulls or pushes the carriers, opens and shuts doors and automatically stops at its destination . . . transport is speedy, trouble-free—regardless of the weather or road conditions, and completely unattended.

A Louden Selectomatic Transport System can do many things not required in the Eljer Company installation. It can automatically transport materials unattended from point to point anywhere in or about your plant, and can select the shortest and most direct route, opening and closing switches to its destination. It can travel from floor to floor and building to building, open doors to let itself through and close doors behind it. It stops promptly when there is a load ahead or when it does not have the right of way, and resumes travel when the way is clear. It stops accurately at its destination and even loads and unloads its own carriers with certain classes of materials. It returns empty carriers to point of origin or places itself in storage awaiting the next call.

Louden Automatic Materials Handling is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. Both the Louden field representatives and the factory engineers are highly trained specialists in the field of overhead materials handling. When you have materials requiring handling, lifting or transporting, call on Louden for suggestions. This will cost you nothing but may prove to be the most profitable move you have ever made.

NEW **. . . 52 pages of illustrated applications . . . industry by industry. Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES."**

Louden

MONORAIL & CRANES

THE LOUDEN MACHINERY COMPANY

706 Broadway, Fairfield, Iowa

A subsidiary of Mechanical Handling Systems Inc.

SINCE 1867 . . . THE FIRST NAME IN MATERIALS HANDLING

Circle 658 on Page 19

AUTOMATION news

Today's events and developments in the field of automation

Machine Tool Builder Unveils Advances At Anniversary Show

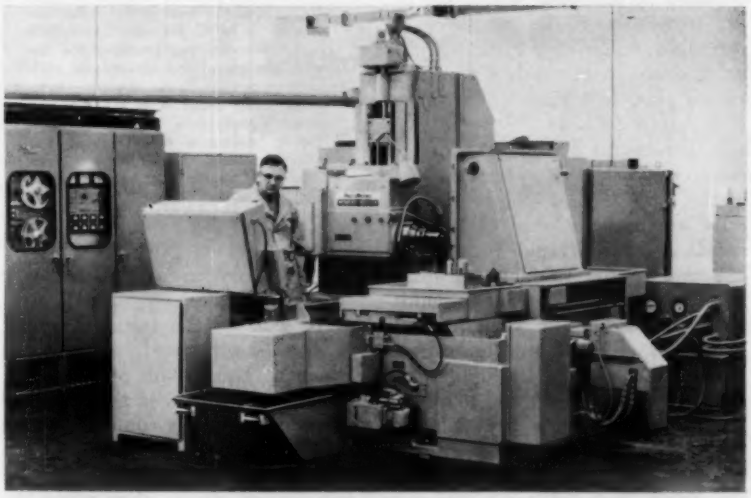
COMMEMORATING its 100th Anniversary in business as a machine tool manufacturer, Pratt & Whitney Co. Inc. has recently established a permanent display area at its West Hartford, Conn., plant. Known as "Centennial Hall," the area will be used to feature exhibitions of the company's products.

Among the newer developments on display in the Hall during a recent Centennial Show was a tape controlled, continuous milling machine that can mill regular or irregular shapes in three dimensions. The horizontal and transverse motions of the table, vertical motion of the cutter spindle, and feed rates are automatically controlled by coded punched tape.

An operator is required only to load and unload workpieces, push a button to start the tape, set spindle speeds, and change tools as required. The machine is said to be suited for both short and long-run production, particularly in tool and die operations.

Designated Numeric-Keller, the machine embodies many of the con-

VERTICAL rotary table can be numerically controlled to assume any angle in 360 degrees with respect to a preset "zero" position. Accuracy is within 5 seconds of arc. Unit, which is suitable for a variety of machining or inspection jobs, can be rotated rapidly in either direction for setup purposes by means of pushbutton controls.



TAPE-CONTROLLED, continuous milling machine has been set up for demonstration in permanent exhibition area at Pratt & Whitney Co. Inc. Unit features coded punched tape control of horizontal and transverse motions of worktable, vertical motion of cutter spindle, and feed rates. Workpieces can be milled in three dimensions without the need for fixtures, templates, or models.

structional features of the company's tracer-controlled milling machines. In addition, it has been equipped with the Bendix Corp. tape control system. In contrast to tracer-controlled milling, the numerically controlled machine requires no templates, models, or fixtures. On many jobs, this can result in cost savings up to 75 per cent for tooling and production lead time.

To prepare a tape for machine operation, a line drawing of the part is translated into a numerical drawing which a process planner uses to complete a process sheet. Information shown on the process sheet includes setup point, table movements, tolerances, feed rates, tool sizes, and circle radii. A paper tape is then punched from the process sheet data and verified. This tape is fed to a general purpose digital computer which makes necessary calculations and perforates a machine-control tape. Symmetrical left and righthand parts may be machined with the same tape.

Since the numerically controlled machine is run at maximum speeds and feeds during all phases of the machining cycle, machining costs can be reduced considerably over conventional milling. In addition, the accuracy and uniformity of finished parts can effect savings in the cost and extent of inspection. Parts have excellent surface finishes because of the smooth, continuous path taken by the cutting tool.

Another new development unveiled at the Centennial Show was a numerically controlled, vertical rotary table. The unit, which can automatically position to any desired portion of a 360-degree circle with an accuracy of 5 seconds of arc, is suitable for either machining or inspection operations. Digital positioning information for the device may be introduced by telephone dial or by punched coded tape. For setup

purposes, rapid rotation of the table in either direction can be accomplished with pushbutton controls. A digital display panel on a control console gives a visual indication of the table position in degrees and decimals of a degree.

All positioning of the vertical rotary table is accomplished in relation to a preset "zero" which can be set anywhere on the periphery of the table. A *Zero-Set* knob permits an operator to establish a zero reference point in a matter of seconds.

A numerical-head jig borer was also demonstrated that incorporates tape control of the workhead as well as the table. This machine provides fully automatic control of spindle speeds and feeds, rapid-traverse positioning of the spindle and quill above the work, and boring depth and cycle. Equipped with Pratt & Whitney's Electrolimit measuring system, the machine is said to be capable of locating within "tenths," and to maintain this precision indefinitely.

Other equipment on display at the Show included tracer control equipment, a new production lathe, and a helical path analyzer for measuring screw threads.

LINE of miniature industrial oil-tight pushbutton units developed by General Electric Co. can effect panel space savings of up to 40 per cent. Illustration compares space requirements of the new units (top group) and conventional pushbutton controls (lower group). Functional forms available in the new line include pushbuttons with or without guards, mushroom head buttons, and selector switches. Pushbuttons and mushroom head buttons may be illuminated, and push-to-test indicating lights may be provided.

Open Hearth Process May Step Up Steel Production

STEELMAKING process developed by Ford Motor Co. promises to reduce by one-half or more the time required to produce steel in open hearth furnaces. Ford, 13th largest steel producer in the U. S., has successfully experimented with the process in 200 and 400-ton furnaces in its steel plant.

The new process is essentially a revision of the conventional open hearth method. It makes use of a combination of oxygen and fuel, and substitutes burned lime for limestone, in order to hasten the thermal and chemical reactions that convert scrap and molten iron into steel.

In experiments, a basic charge of 50 per cent scrap and 50 per cent hot metal has been used. The scrap is charged first along with burned lime. Heat is supplied during this phase from oxygen-enriched fuel burners at the ends of the furnace and from oxygen-fuel lances in the roof of the furnace.

As soon as the initial charging process is completed, molten iron is added. During this operation the fuel for the lances is shut off, but the oxygen flow is continued. The heat from the end burners and the chemical reaction, and the continuous flow of oxygen, then refine the steel.

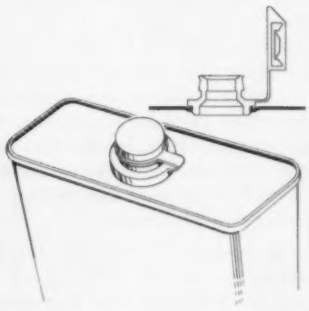
To date, more than 15 heats have been made following this procedure in the 200 and 400-ton open hearth furnaces at the Ford plant. In the 200-ton furnace a composite heat average of 67.6 tons per hour has been obtained. Limited data on the larger furnace show that approximately 100 tons per hour can be expected.

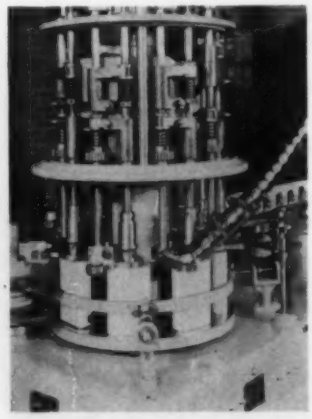
According to Henry Ford II, president of the firm, the process is still in the experimental stage and applies only to the production of steel in open hearth furnaces. Even if future experiments confirm the promise of the new process, Ford plans to continue buying the greater portion of its steel from outside suppliers.

Streamlined Data Processing For Machine Tool Exposition

TWO time-saving features have been devised for the convenience of visitors to The Machine Tool Exposition—1960, to be held at the International Amphitheatre in Chicago next Sept. 6-16.

The first time-saver has to do with registration at the Exposition. To handle the 125,000 top executives, production men, engineers, and educators who are expected to attend, a system has been set up by which a visitor can register by merely presenting a filled-in Rapid Registration card together with a $3 fee. Rapid Registration cards are





PLASTIC captive closures are assembled automatically to quart and pint metal cans for floor waxes and polishes on this eight-spindle rotary capper. In operation, an arm associated with each spindle swings out to pick a closure from a feed track. The arm then swings inward, centering the closure under a chuck on the spindle. The chuck orients the closure by rotating it until vertical stops are contacted. Then the chuck descends, inserting the closure in a hole in the can. The arm also drops during the assembly operation to hold the can centered under the chuck. Production rate of the machine, developed by Consolidated Packaging Machinery Corp. in conjunction with Continental Can Co., is approximately 200 assemblies per minute for quart cans and 250 per minute for pint cans.

America's finest automatic transfer machines now available to outside companies!

You know Sylvania for light bulbs, radio tubes, fine electronics equipment. (You also know how exacting specifications have to be to make such fine products on automation machinery.) Over 20 years ago Sylvania discovered there were no transfer machines available to meet our unusual standards of required accuracy. To get the exceptional machines we needed, we had to make them ourselves. We have been doing it ever since.

Now these machines are available to outside companies seeking this same extraordinary degree of accuracy.

Ideal for high-speed automatic fabricating, finishing, assembling, indexing, packaging, these machines are available in two general types:

1. Rotary indexing chassis in two sizes and in single and double turret models. Made with unusually great driving and tool capacity. Note: top of transmission spider is specially machined for rotary vacuum or pressure valve.

2. Conveyor indexing chassis, exceptional for the extreme accuracy, strength and versatility of its chain—not made commercially, but by Sylvania itself. You also get greater tool and driving capacity than in other such chassis on the market.

Also, precision indexing transmissions (5 models)

- **Heavy-duty unit** with extra-large cam well and spider diameter for wider range of stops per revolution.
- **Standard unit** features higher cam speeds, a provision to integrally mount rotary vacuum or pressure valves.
- **Universal unit** operates with its output shaft horizontal or vertical. Has wide range of applications.
- **Small universal unit.** Lower silhouette and extra-long input shaft are main features of this extremely durable, accurate transmission.
- **Conveyor unit.** Very rugged, heavy-duty unit designed for conveyors, but easily adaptable for rotary tables, other intermittent motion machines.

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121 Loring Avenue, Salem, Mass.

Please send me free brochure of:

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Position_____

Company_____

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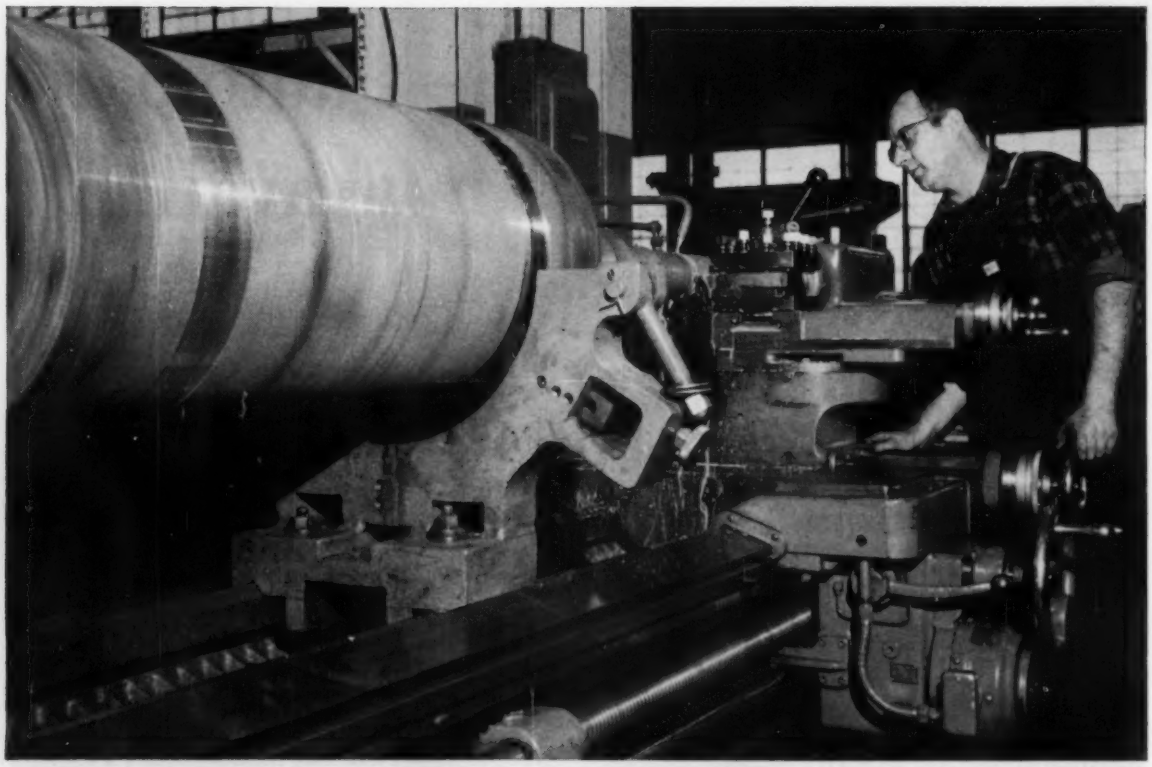
City_____ Zone_____ State_____

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

Circle 659 on Page 19



RELIABILITY:

Reason enough to buy LeBlond

Valuable as five fingers on a hand, these five great LeBlond lathes run round the clock, year in, year out, at the Warren, Ohio, shops of Wean Manufacturing Co. Wean has six LeBlonds in all, including the five in the picture, all purchased in the last five years.

The operations they perform are typically job-shop. Lots are small—five parts alike are a big run; materials may vary from hardened steel to copper. Fat mill rolls, long whippy spindles, sturdy stepped shafts—the rugged LeBlonds take them as they come and turn them quickly and accurately, regular as clockwork.

Much of Wean's output goes into steel mill equipment that can be relied on to hold up under the most exacting requirements—the same steadfast degree of reliability that LeBlond lathe customers expect, and get.

RELIABILITY is a good reason to buy a lathe. It is reason enough to buy LeBlond.

See LeBlond Booth 810 at the Machine Tool Exposition in Chicago, September 6—16. MMT-PE

THE R. K. LEBLOND MACHINE TOOL COMPANY
Cincinnati 8, Ohio

LeBLOND *of Cincinnati*

obtainable from machine tool builders, machine tool salesmen and distributors, magazines, and the National Machine Tool Builders' Association. There will be no advance registration.

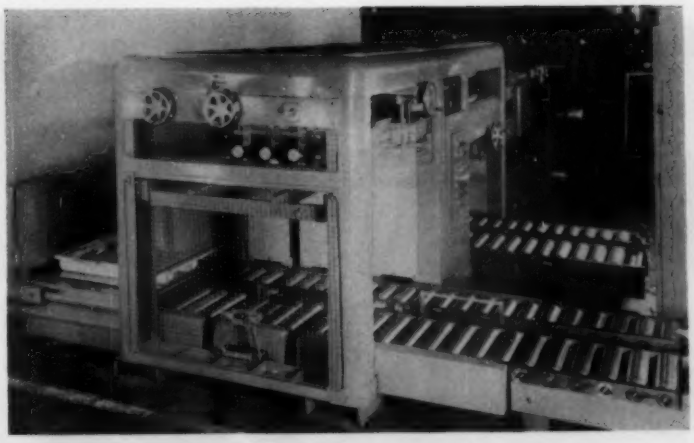
The second time-saving feature applies to the processing of requests at exhibitors' booths for further information to be mailed to visitors. To avoid the time-consuming necessity of taking down in longhand the name, address, title, etc., of each visitor requesting additional information or service, exhibitors will have imprinting machines at their booths. These machines will quickly record such data from embossed plastic Inquiry Time Saver plates carried by visitors. Inquiry Time Saver plates may be obtained at the Exposition or in advance through request cards that will be distributed widely by salesmen of machine tool builders and distributors.

European Automaker Buys U. S. Machine Tool

CONTINUOUS horizontal broaching machine built by Detroit Broach & Machine Co. will be installed shortly in the plant of a European automaker. The 20-ton unit, which has a 144-inch stroke, will be used to perform two separate broaching operations in a single pass on a manual steering gear ball nut.

Production rate of the unit, with nine fixtures moving at 13.6 fpm, is 182 pieces per hour. For increased output, up to 18 fixtures may be used and the machine speed increased by means of change gears.

A single operator feeds part blanks into the fixtures as they move past an input section on an endless chain. As they approach a first broaching section, the fixtures lock automatically, and the tops of the ball nut rack teeth are broached. Next, the fixtures are moved to a section where a slide bar and cam act to tilt each fixture. The tilted fixtures then enter a second broaching section where multiple rack teeth are broached simultaneously in each part. At the end of the cycle, the finished parts are unloaded automatically from the fixtures and move on a conveyor to the next op-



Sheet Metal Grader Segregates And Stacks By Quality

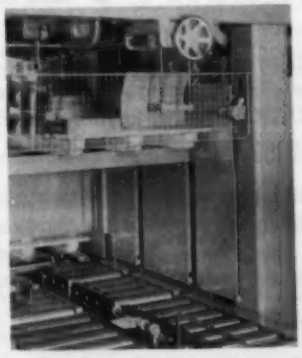
TWO-STATION sheet metal grader developed by Bren Mfg. Co., Gateshead, England, separates and collects prime and reject sheets issuing from a sheeting line. Built for F. J. Littell Machine Co., the unit is designed to be placed at the exit end of a shear line that cuts coil stock into discrete pieces. Sheets measuring from 18 by 24 inches to 44 by 38 inches are handled by the grader at rates up to 175 per minute.

In operation, sheets are fed to the grader on a conveyor leading from the shear. A reject gate on the grader is positioned automatically by a signal generated at an inspection station. Characteristics checked at the inspection station include thickness, perforations, and surface condition.

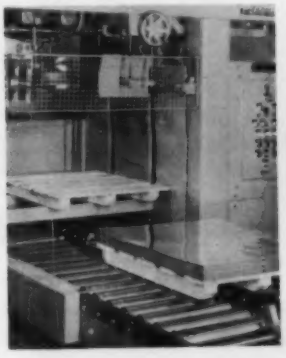
Sheets that are to be rejected are routed by the gate to the first grader station where they are collected on pallets. Prime sheets that pass inspection proceed to the second grader station and are likewise stacked on pallets. Each pallet can hold up to 9000 pounds.

At the second grader station, positioning of pallets, counting of sheet loads, and lowering and ejecting of full pallets are automatic. At the first grader station, full pallets are rolled out manually, since usually only two pallet loads per shift are involved.

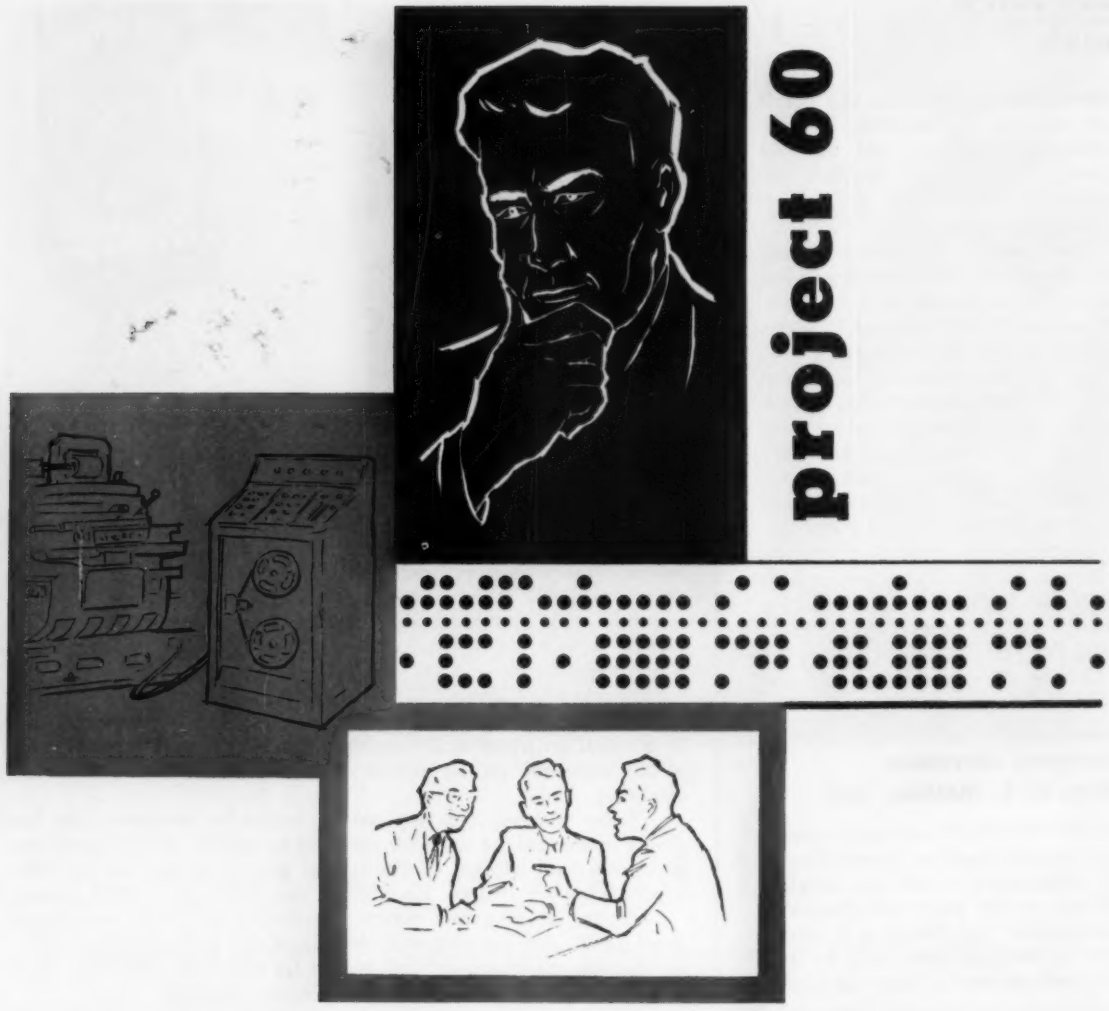
When it is desired to remove a sheet from the line for detailed inspection, a mechanism near the reject gate may be actuated so that a sheet is thrown onto a rack above the input conveyor.



SHEETS are shown being loaded on elevated wooden pallet at prime stacking station. Photoelectric cell, below and to right of handwheel, senses height of stack and initiates machine cycle to eject full pallets and replace them with empty pallets from magazine at rear.



LOADED pallet has been lowered and moved on rollers. Empty pallet, picked up on screw-driven beams, is rising to pick up sheets being stacked temporarily on prongs projecting from right side of machine. Prongs retract automatically when pallet is fully raised.



directed to industry's men of decision

PROJECT 60 will present industry's latest developments in numerically controlled machines. This exciting editorial section will appear in the August issue of AUTOMATION. It will keynote the 1960 Machine Tool Exposition and Production Engineering Show to be held in Chicago, September 6-16.

PROJECT 60 will report today's progress and predict the future potentials of numerical control in industry. Top management, manufacturing engineering, and production executives will gain a broad, fresh, new approach to the use of numerical control on production equipment.

Watch for PROJECT 60 . . . along with other outstanding editorial features in the August issue of

AUTOMATION

penton building/cleveland 13, ohio

Steel Warehouse Handles 3500 Stock Items with "TRAK-RAK" Crane
——— *Reduces Operating Costs... Speeds Service*

1. "TRAK-RAK" Crane moving into aisle between double rows of racks. Racks are 20 ft. high. Distance from floor to underside of roof truss is 30 ft. Aisle width is 5 ft.-4 in.

Edgcomb Steel of New England, Inc. warehouses 3500 different items of steel, stainless steel, brass, and aluminum bar stock in an area 60 feet wide, 27 feet high, and 160 feet long.

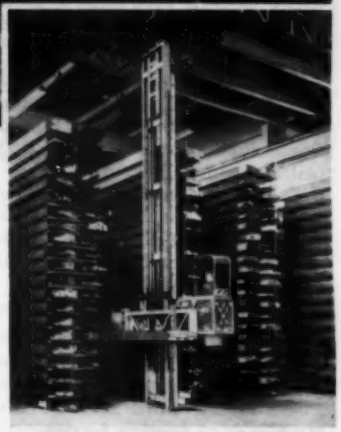
ONE man and a "TRAK-RAK" Crane serve the five double rows and two single rows of "Christmas Tree" racks which hold 2700 storage trays. Edgcomb processes approximately 2500 to 3000 orders per month, and the company reports very favorable reductions in operating costs and faster order processing and delivery.

Edgcomb's "TRAK-RAK" Crane has a traveling bridge (Photo 1) which spans the storage bay, and an overhead trolley from which is suspended an electrically operated rotating column equipped with a carriage for handling the storage trays. All operations of the crane and carriage, which rotates, moves toward or away from the racks, and raises or lowers on the column, are controlled by the operator who rides with the carriage. Safety switches prevent the column from running into a rack and permit full rotation only when the unit is safely beyond the end of the racks.

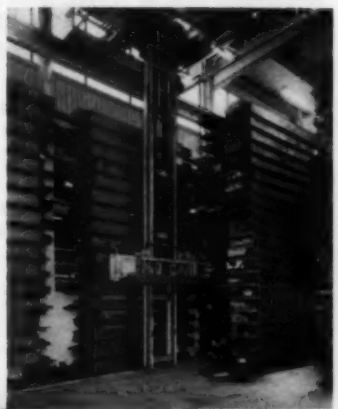
Hundreds of "TRAK-RAK" installations, designed to meet the user's particular requirements are in use today. They are handling many types of material and loads with great speed and economy. Specific advantages the "TRAK-RAK" System of vertical storage and handling brings to the user are:

1. **Maximum utilization of the cube to permit storing and handling more material in less floor area.**
2. **Faster material movement in and out of storage.**
3. **Reduction in personnel and lower labor costs.**
4. **Improved safety, better housekeeping, precise inventory control.**

Take the first step toward faster, more efficient material storage and handling now. Write for complete details on "TRAK-RAK." Chicago Tramrail Engineers are available to discuss your handling problem with you at any time—and at no obligation to you.



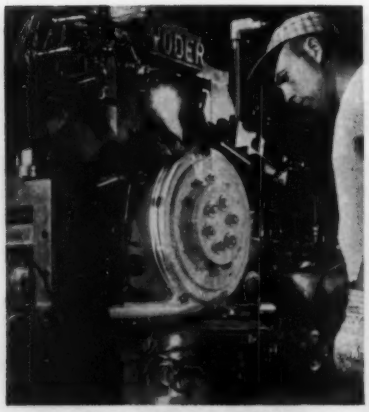
Crane with operator, who rides with carriage, emerging from aisle with loaded stock tray.



Picking up or depositing stock trays on the rack is a fast, safe operation. Trays and rack sections are color coded for quick location and identification.

CHICAGO TRAMRAIL CORPORATION
1306 SOUTH KOSTNER AVENUE • CHICAGO 23, ILLINOIS

Specialists in the design, manufacture and installation of material handling systems for steel warehouses and other industries



Yoder Tube Mills speed tailpipe production at AP Parts Corporation

The AP Parts Corporation (Toledo, Ohio), world's largest producer of replacement mufflers and tailpipes, uses 2 YODER Tube Mills to produce more than *300* ft. of 1¾", 1⅞" and 2" tubing per minute.

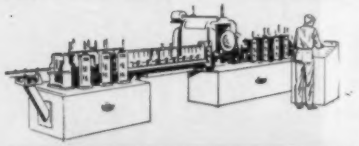
According to Mr. John Grindle, Plant Engineer, the two-man operated YODER Mills are vital to the production of the entire plant. "YODER Tube Mills earn their keep daily. They are easy to set up, maintain and operate ... the welds are clean and uniform. We depend on them for constant quality, high production and minimum downtime".

The YODER Tube Mills at AP Parts exemplify the production economies and dependability of all YODER-built equipment, whether it be Pipe and Tube Mills, Cold Roll-Forming Machinery or Slitting Equipment.

If your products require ferrous or non-ferrous pipe or tubing, from ¼" to 26" diameters, there is a YODER Mill designed to produce it economically, accurately and efficiently.

For complete information on YODER Pipe or Tube Mills ... write for the fully illustrated, 88 page YODER Tube Mill Book ... it is yours for the asking.

THE YODER COMPANY
5526 Walworth Avenue • Cleveland 1, Ohio



ENGINEERING YODER MANUFACTURING
PIPE AND TUBE MILLS
(ferrous or non-ferrous)

Circle 662 on Page 19

CALIBRATION of electric meters at Philadelphia Electric Co. is carried out efficiently at test stations placed on either side of a double-deck belt conveyor. Meters enter area from right on upper conveyor at operators' shoulder height. Tested meters are placed on lower belt for movement to final inspection and packing station. Setup is part of an extensive meter handling system supplied by Alvey Conveyor Mfg. Co.

eration. Surface finish tolerances for completed workpieces range from 18 to 25 microinches.

Believed to be the largest continuous broaching machine ever built, the unit will be shipped this season via the St. Lawrence seaway to Europe.

Cites Computer Control As Growing Trend In Automation

INCREASING use of computers in industry, either for information or control, will be the greatest development in automation in the 1960's according to **Dr. Robert C. Langford**, director of engineering for Weston Instruments Div., Daystrom Inc.

Speaking at a recent meeting of the National Industrial Conference Board in New York, Dr. Langford said that, like other forms of automation, electronic computer control minimizes or eliminates the human element "with its proneness to tire, to err, and to fall behind the potentials of machines." He added that electronic computer control is concerned with those aspects of industrial activities which heretofore have relied on the mental faculties of man—his observation, skill in calculating, and reaction time.

"A computing system for an industrial plant can be achieved by designing and engineering a group of components into an integrated system," the Daystrom executive said. "If this system is designed to provide operational information only, the components will sense, signal, analyze, and do the computations upon the parameters of a process in such a way that decision-making information is supplied quickly, accurately, and completely to the human operators of a plant.

"If, on the other hand, the system is designed for control, it goes on and acts upon this computed information in line with instructions that it has received from a human programmer at a previous time. It can start up, shut down, and operate a plant or some section of it, in accordance with those instructions."

Thermoelectric Modules Show Increased Efficiency

THERMOELECTRIC modules developed by General Thermoelectric Corp., a newly formed subsidiary of General Devices Inc. and Needco Cooling Semiconductors Ltd., are said to provide more than twice the heating and cooling efficiency of comparable devices. Industrial applications for the modules include use in removing heat from high-power transistors in electronic equipment, cooling photomultiplier cathodes, and as reference junctions for calibrating thermocouples. Devices may also be used in dew-point hygrometers and to cool microscope and microtome tables.

Each basic module, called a Frigistor, includes eight thermocouples

around the triangle

MEASURES BEARING TEMPERATURES ON THE FLY

Detection of overheated railroad car wheel bearings due to improper journal operation or dragging brakes is the job performed by a scanning unit developed by General Railway Signal Co. in conjunction with the Apparatus & Optical Div. of Eastman Kodak Co. The system makes use of three major components: A wheel detector that senses the presence of a wheel at a measuring point; a trackside radiometer head, energized by the wheel detector, that detects infrared radiations emanating from the hubs of wheels; and a control unit. Output of control unit may be used to actuate a recorder when permanent records of wheel temperatures are desired. Equipment is suitable for either plain or roller bearings, and requires a test time of only 0.000015 second per wheel.

TRANSDUCER RESPONDS TO FREQUENCY DIFFERENCES

Synchronous differential designed and built by Kollsman Motor Corp., a subsidiary of Kollsman Instrument Corp., is suitable for automatically synchronizing machines by regulating the frequency of one power supply with respect to another. The unit employs two hysteresis-type synchronous motors and a mechanical differential. In operation, each synchronous motor is connected to a separate power supply, one of which may represent a control or master frequency. Where the two input frequencies coincide, the output shaft of the differential remains stationary. However, if one frequency differs with respect to the other, the output shaft of the differential will rotate at a speed equal to one-half the difference in speed of the two synchronous motors. Motion of the shaft thus can form a basis for control.

ACIDITY CONTROL IMPROVES TIRE QUALITY

To prevent the development of hairline cracks in automobile tires when they are exposed to road wear, a leading tire manufacturer has found that he must control the acidity level of his rubber curing process at a pH value of 6.8. This is accomplished at a stage of the process where the rubber is passed through tanks of water to which acid is added. The pH control system, designed and built by Hagan Chemicals & Controls Inc., includes a water flow meter, a pH sensing device, and a pneumatic recorder-controller. Water flow is measured continuously by the flow meter and used as a basis for adjusting the stroke of an acid feed pump. At the same time, acidity level sensed by the pH sensing device is converted by the recorder-controller into a pneumatic signal. This signal is used to operate an acid feed relay that automatically maintains the pH concentration at the proper level.

CONTROLS MONITOR ENGINE OPERATION

Development of a control system for automatically starting, loading, and shutting down internal combustion engines in gas compressing applications has been announced by the Fulton Sylphon Div., Robertshaw-Fulton Controls Co. The pneumatically actuated control system incorporates safety functions to shut down the engine in the event that any of several operating variables—temperature, pressure, liquid level, vibration, and engine speed—go outside preset limits. Starting of an engine is initiated when a pushbutton is depressed on a control panel or at a remote station. This causes starting of auxiliaries, opening of a starting air valve, ungrounding of the ignition system, and opening of the engine's fuel valves in the proper sequence. If any individual function fails to reach the correct operating level, the system will lock out, and the engine must be restarted from the initial stage following correction of the malfunction. Annunciators identify the types of malfunctions that are sensed by the system.

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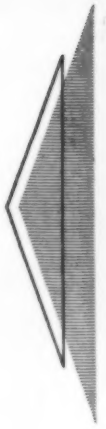

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406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
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412	452	492	532	572	612	652	692	732	772	812
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422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	759	799	839
440	480	520	560	600	640	680	720	760	800	840

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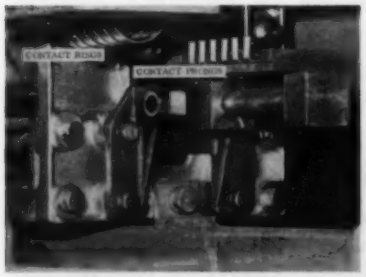
made from a special semiconductor alloy. The alloy consists of four materials—antimony, bismuth, selenium, and tellurium—and is said to be the first quaternary alloy to be marketed for thermoelectric applications. Previously, binary and ternary alloys have been used for this purpose.

The subsidiary will concentrate initially on marketing the basic modules, which are available in molded plastic cases measuring approximately 1 x 1 x ¼-inch. Engineering services will be available to assist in adapting the units to industrial, scientific, and military requirements.

Machine Tool Builder Expands Plant Facilities

EXPANSION and modernization of plant facilities has been announced by H. R. Krueger & Co. as part of a long-range diversification program. According to company officials, the concern, long a major supplier of machine tools and automation equipment to the automotive industry, initiated the program in order to meet growing demands for its products from other industrial producers.

R. B. Aspinwall, president of the firm, said, "With our new capacity, we are prepared to meet industry's need for larger, more specialized, and unusual kinds of machines—high production, continuous cycle, precision equipment that is flexible enough to serve a variety of purposes." Typical industries that can



DISPATCH keys associated with carriers function as carrier guides and controls in a programmed conveyor system developed by Abbey Process Automation Inc. In operation, a key which has multiple prongs bent upward in a coded pattern is placed on each carrier at a loading point. As the carrier approaches a station, the contact prongs engage matching contact rings in station receiver units. Course of action at each station in the system is determined by the coding of the key.

EDWIN L. WIEGAND COMPANY
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Heat liquids .....at the turn of a dial

CHROMALOX ELECTRIC HEAT

Fast, uniform, economical, safe

Just drill and install threaded pipe coupling in tank, then screw in the Chromalox Immersion Heater. Built-in thermostat automatically maintains uniform temperature of water, oils, paraffin, wax, various solutions. Several styles available, for different applications. Elements sheathed in copper or steel. Standard ratings from 50° to 550°F., ¾ to 10KW, 120 or 240 volts. Inside-tank extensions from 6¼" to 48". Available with explosion-resistant and moisture-resistant terminal box. Prices start under $20.

For more details, call your Chromalox Sales-Engineering Representative, or write us for Bulletin PD105, which contains specifications and prices.

01551

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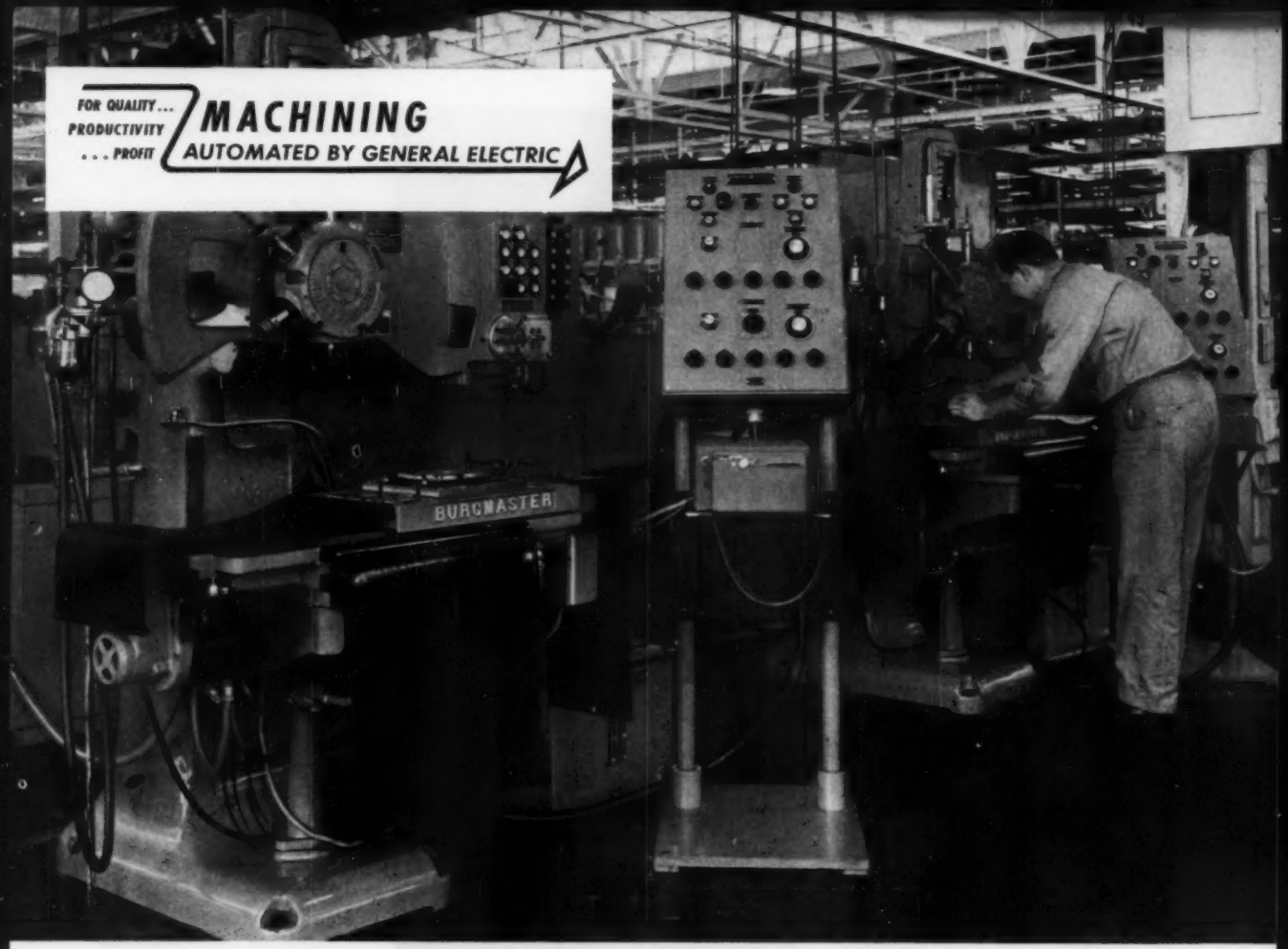


INCREASE WORKER PRODUCTIVITY

MARK SERIES NUMERICAL CONTROLS...

.....standard, job-proved packages now in use on a wide variety of machines

General Electric's Mark series of standard, pre-engineered numerical control packages—with systems for controlling 1 to 5 motions plus machine auxiliary functions—are compiling impressive performance records on scores of machines throughout American industry today.

Machine operation is completely automatic—from punched tape prepared on a standard automatic typewriter. If desired, semi-automatic positioning, useful for prototype work, is obtained with manually set dials on the control station.

Key components of a typical Mark package are a controller, a punched tape reader, operator's control station, servo drives and position-sensing units.

8-TO-1 TIME REDUCTION in press operations is achieved on this 100-ton rotary-turret punch press directed by General Electric numerical control. Rapid positioning of table and turret provides up to 40 punches per minute.

40% AVERAGE TIME REDUCTION for all parts produced on this horizontal boring machine means greater output and better equipment utilization. Lead times are cut by 8-to-1, and non-productive worker time is reduced by more than 60%.

with General Electric numerical control

Boost output of man and machine, reduce in-process inventory

Over the past 7 years, management has seen labor costs increase by 50% with productivity up by only 15%. This profit-cutting gap has accelerated an industry-wide need for production methods such as General Electric numerical control.

Key benefits of G-E numerically controlled machines include increased worker output, increased machine utilization, and reduced in-process inventory in virtually every job.

Manufacturers are now realizing far greater output per man-hour . . . faster "pay-back" rates on machines . . . shorter production cycles . . . and much lower inventory investment—in itself justification for numerical control. Here's an example:

Automatically controlled turret drills are used to produce aircraft-engine accessories at Chandler Evans Corporation, West Hartford, Conn. With numerical control, direct-labor costs have been cut in half! The machine operator — working two machines simultaneously — loads the piece, sets the machine in operation, and all production is performed automatically. But, increased productivity is only part of the story. Scrap losses are virtually eliminated, average lead times are cut by 6-to-1, cutting-tool costs are 1/40th of former production methods, and tool life is increased from 30 to 1300 pieces per tool—all adding up to expected *annual* savings of $42,000, more than enough to pay for both machines within two years.

Join with Chandler Evans and hundreds of other manufacturers who are increasing productivity, gaining better product quality, and eliminating tooling cost with G-E numerically controlled machines. See your G-E Apparatus Sales Engineer or machinery builder today. General Electric Co., Specialty Control Dept., Waynesboro, Va. 793-7

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 664 on Page 19

be supplied are those engaged in the manufacture of tractors and other farm machinery, heavy duty marine, outboard, and aircraft engines, and others requiring standard and special purpose machine tools.

Most of the machines the company has recently designed and built are of standard modular construction. This concept enables modification of basic functions to suit individual needs. Another advantage of this type of construction is that additional functions, such as those often required by model changeovers, can be achieved at minimum retooling costs to manufacturers.

FRICTION between a moving carton and the printing drum of a marker causes imprinting of the carton in this application at Eastman Kodak Co. As each carton moves to the left on a conveyor (at bottom, not shown), the printing drum is turned one revolution or less to a positive stop. During this motion, inked characters mark the carton with a desired code. Unit is manufactured by Industrial Marking Equipment Co. Inc.

Vacuum Brazing Furnace Operates Continuously

CONTINUOUS production vacuum furnace designed by the National Bureau of Standards can maintain a vacuum of 0.00001-inch Hg in a heating area while ceramic wafer tube assemblies are processed at rates up to 200 assemblies per hour. The furnace was designed for the Navy Bureau of Aeronautics as a part of the Navy's industrial preparedness program. Mechanical development and construction of the furnace were undertaken on contract by Sanders Associates Inc.

The vacuum furnace includes a vertical, heat-resistant alloy tube, about 11 feet long, that is open to the atmosphere at both ends. Through this tube is passed a series of cylindrical parts carriers, each of which is separated by a short piston that fits closely inside the tube. Assemblies placed in the carriers enter the top of the tube at atmospheric pressure.

As the pistons are lowered into the tube, the cavities formed between them are evacuated through ports along the side of the tube. Thus, when they are heated to 1000 C in a central zone, the assemblies in the carriers are under vacuum.

In the heating zone, the combination of heat and vacuum degasses the tube assemblies. At the same time, the high temperature brazes together the metallized surfaces of the ceramic wafers to produce hermetically sealed units. After processing, the assemblies are removed from the lower end of the tube at atmospheric pressure and reduced temperature.

According to NBS officials, the furnace could be adapted for uses other than continuously processing ceramic vacuum tubes. For example, it could be used for the coating of lenses or resistors by vapor plating and for the production of vacuum condensers and switches. Where processed articles must come out of the vacuum at near room temperature, the lower end of the furnace could be lengthened and water cooled.

Technical Bulletin Describes Voltage Digitizer Uses

APPLICATIONS information concerning its line of voltage digitizers has been compiled in the form of a bulletin recently published by Adage Inc. Among the uses listed for

Control Console Programs Voltage Breakdown Tests

PORTABLE test set designed and built by the High Voltage Specialty Transformer Dept., General Electric Co., performs programmed voltage breakdown tests on insulated coils used in motor-generators. The device is in use at the company's Medium A.C. Motor and Generator Section.

In operation, a probe connected by shielded cable to a control console is clipped to an exposed conductor on a coil. The coil, suspended on a rack, is then lowered into a tank until it is almost completely immersed in water.

When a pushbutton on the control console is depressed, a test cycle is initiated. During the test cycle, a motor-operated, variable-voltage control is advanced automatically. The result is that an electrical potential, rising at the rate of 500 volts per second, is impressed on the shielded cable, probe, and coil conductor. When the potential reaches a specified maximum voltage with respect to the liquid

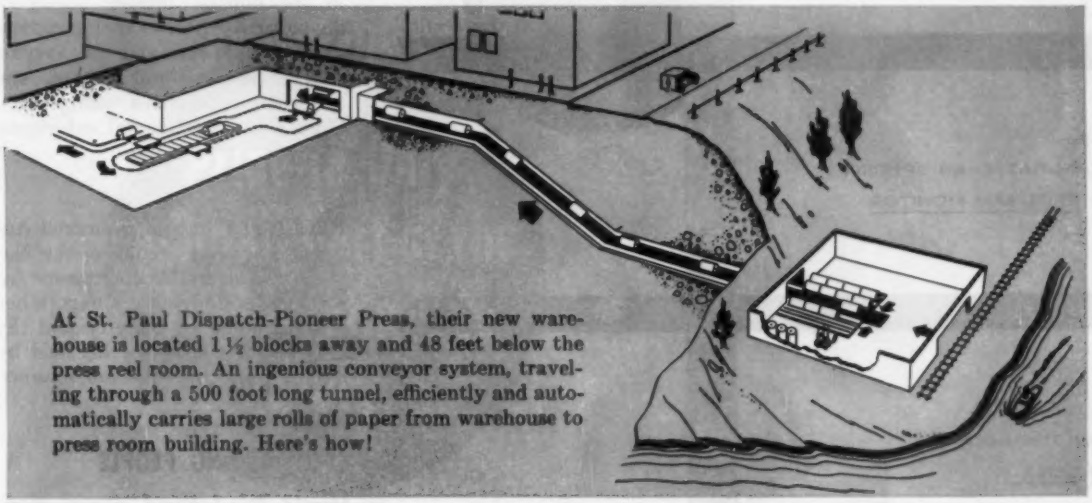
on the outside of the insulation, a timer starts a *Hold* cycle. At the end of the cycle, the control is returned to its zero voltage position and the test set is de-energized.

If the insulation fails during the test cycle, the test voltage will immediately return to zero. A red signal light then goes on indicating a failure. At the same time, the voltage at which the insulation failed is indicated on a voltmeter for recording purposes. The time at which the failure occurred is also recorded.

Safety features include an emergency *Stop* pushbutton and an interlock that prevents operation of the equipment unless the variable-voltage control on the console is first reset to zero. Testing is performed in a special cage, and a flashing red light is operated when the equipment is in use.

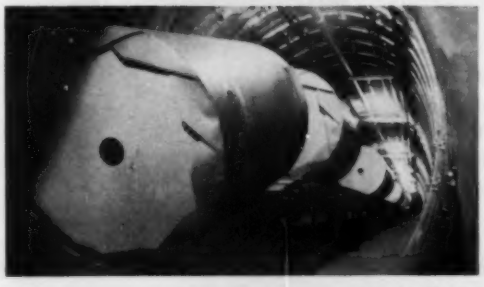
According to G.E. engineers, the test set provides improved quality records in the form of both time and voltage at which insulation failures occur. In addition, the new unit produces more uniform tests without the need for highly skilled operators.

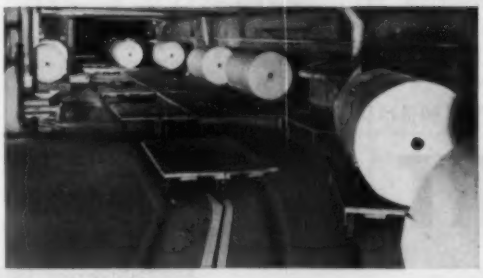
This Webb automatic conveyor system hustles newsprint thru 500 foot tunnel



At St. Paul Dispatch-Pioneer Press, their new warehouse is located 1½ blocks away and 48 feet below the press reel room. An ingenious conveyor system, traveling through a 500 foot long tunnel, efficiently and automatically carries large rolls of paper from warehouse to press room building. Here's how!

ROLLS REALLY KEEP ROLLING





1. At warehouse, the newsprint rolls (60" long x 36" in diameter and weighing 1500 lbs.) are removed from railroad cars by lift trucks and stacked for storage or placed on the tunnel conveyor for current use. Systematic loading of conveyor is accomplished by two sets of kicker plates which operate in series to propel four rolls at a time into spaced positions on the conveyor. Kicker plates are actuated by bumper switches and air pressure.

2. Tunnel conveyor is divided into four individually powered sections which can be operated "continuous-run" or separately for programming. The ascending section is built on a 15-degree incline and its slats are rubber coated to preclude slipping of load. A continuous live-supply of rolls (spaced 18 inches apart) is maintained by means of electric eye controls at beginning and end of each section.

3. When rolls reach the press room basement, they are automatically pushed off the tunnel conveyor and onto Towveyor trucks. Thirty-one of these trucks are attached to a moving chain loop in the floor to provide additional live-storage of rolls. In the reel room area, a semi-automatic "kick-off" pushes the rolls from the Towveyor trucks onto press room trucks as needed.

System capacity is 130 rolls, manual handling is eliminated, live and stationary storage is provided, and high efficiency is assured by the soundly engineered solution of this unusual material handling problem.

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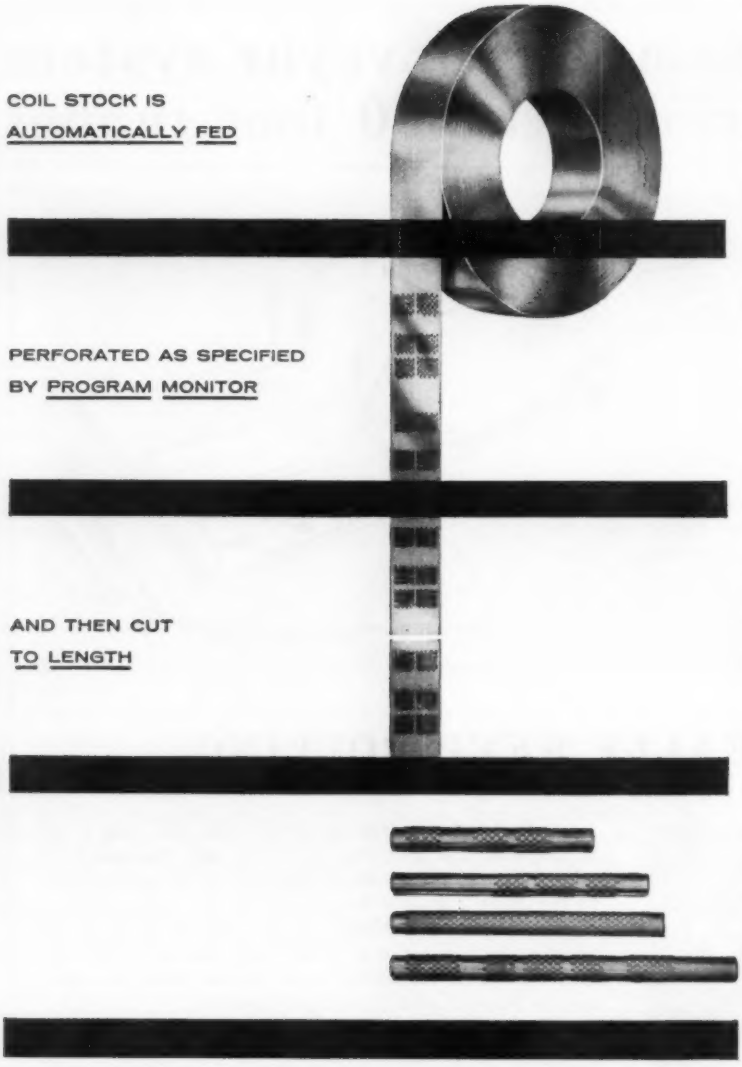
WEBB

JERVIS B. WEBB COMPANY
8945 ALPINE AVENUE • DETROIT 4, MICHIGAN
SPECIALISTS IN CUSTOM CONVEYOR SYSTEMS



PROGRAMMING WITHOUT TAPE WITH ONE SET OF TOOLS

Skip punching device, actuated by a repeating type counter, programs production of automotive muffler tube blanks in standard V & O inclinable press. Auxiliary counter controls blank cut-off. Varying perforation patterns are achieved with one set of tools. Integrating standard type mechanisms such as these to effect cost reduction illustrates the keen abilities that Emhart press experts can apply to your work improvement projects.

Emhart Manufacturing Co.
Hudson Div., Hudson, N.Y.
Formerly V & O Press Div.

EMHART

Circle 666 on Page 19

the semiconductor-equipped devices are: Production testing of electronic equipment, sorting of consumer goods, testing of magnetic memory cores, data reduction and analysis, and computer linking.

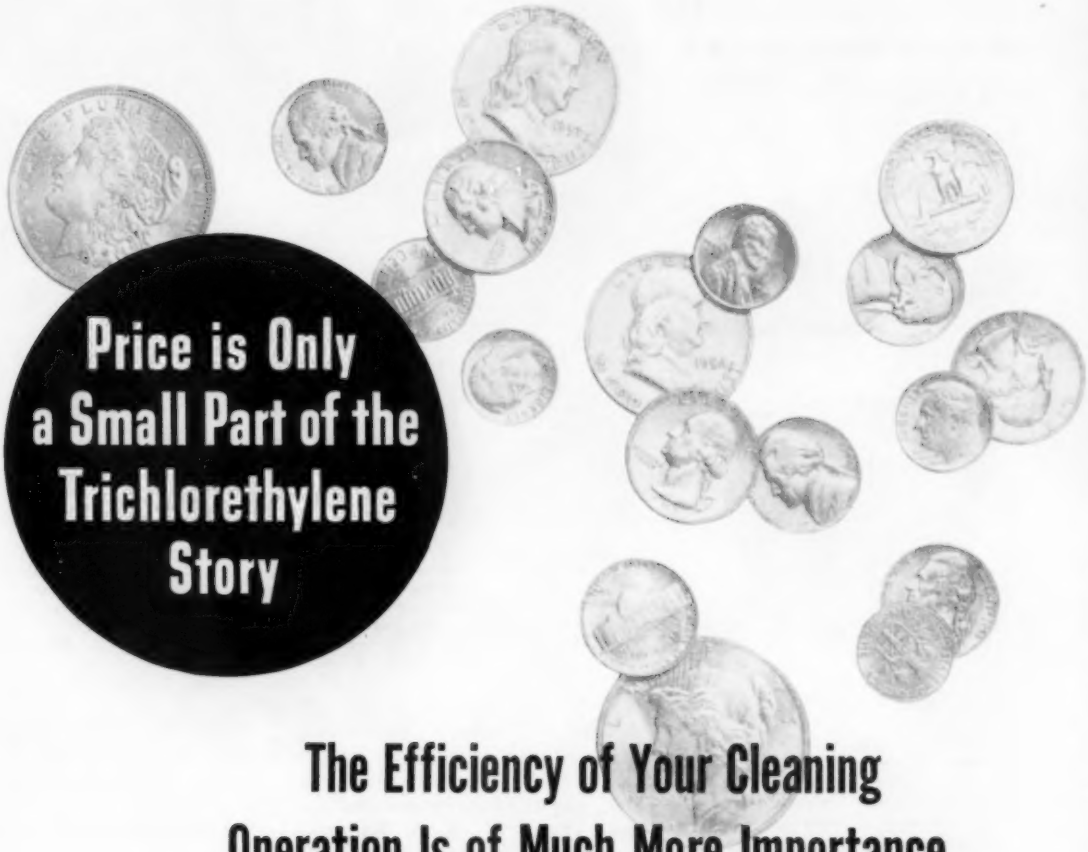
Operations and functions noted in the bulletin include analog-to-digital and digital-to-analog conversion, sample-and-hold of varying analog signals, limit testing, and arithmetic operations using combined analog and digital techniques.

RECENTLY formed Industrial Automatic Systems Section of the National Electrical Manufacturers Association is studying the importance of automation in industry and the role being assumed in this field by electric equipment manufacturers.

SPOTLIGHTING PEOPLE

Harold W. LeBoeuf named manager of manufacturing of the Silicone Products Dept., and **George A. Hagerty** appointed to the newly-established position of manager, process computers, in the Computer Dept., both departments of General Electric Co. . . . **Donald F. Davern** named project manager of industrial control systems at Hughes Aircraft Co. . . . **Louis Polk Jr.** appointed vice president of operations of the Sheffield Corp. and will be in

CORRELATING equipment developed by USI Robodyne Div., U.S. Industries Inc., is used at a message center of Time Inc. to speed distribution of the contents of incoming cabled messages to interested editors. An operator at a console examines each message and determines the appropriate news categories. He then depresses corresponding pushbuttons on the console, and the equipment identifies the recipients of the message and shows the total number of copies required.



Price is Only a Small Part of the Trichlorethylene Story

The Efficiency of Your Cleaning Operation Is of Much More Importance

Detrex Perm-a-clor is universally recognized as a premium grade solvent, selling at regular price. *There is none better.*

Buying from questionable sources or the use of unproved solvent can result in an inferior finishing operation which actually costs money instead of saving it.

One sure way to save *real* money on trichlorethylene is through an expert engineering analysis of the overall degreasing operation—your equipment, your methods, the proper instruction of your people.

Detrex engineers have been making such operational studies for more than 30 years. In many, many instances they have set up a program that has reduced solvent consumption by 15% to 25%. They would like to help you.

Depend on DETREX for Every Metal Cleaning and Processing Need

- PERM-A-CLOR NA (Trichlorethylene)
- Solvent Degreasers
- Ultrasonic Equipment
- Industrial Washer
- Phosphate Coating Compounds
- PAINTBOND Compounds
- Aluminum Treating Compounds
- Alkali and Emulsion Cleaners
- Rustproofing Materials
- Extrusion and Drawing Compounds
- Spray Booth Compounds

Write for Dr. C. E. Kircher's informative article: "How to Get the Most Out of Solvent Degreasing".

DETREX CHEMICAL INDUSTRIES, INC.

Box 501, Dept. A-760, Detroit 32, Michigan

World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

Circle 667 on Page 19

For accurate reproduction of bulk material formulations—W-C BATCH-WEIGHING SYSTEMS

In any batching operation—from simple dump-and-fill weighing to multi-ingredient ratioing — W-C Batch-Weighing Systems provide the reliably accurate net-weight control essential to consistent product uniformity.

Chief reason for this is the W-C Pneumatic Weight Transmitter. A rugged yet sensitive force-balance unit, it is capable of an accuracy of ±0.25% calibrated weight range, with reproducibility better than 1 part in 2000.

Each W-C Batch-Weighing System is designed to job specifications, using pre-engineered, unitized components of *known* performance capabilities. Consequently, you are spared the uncertainties—and costs—of "prototype" engineering . . . yet you realize the very tangible benefits of an application-engineered system built to your requirements.

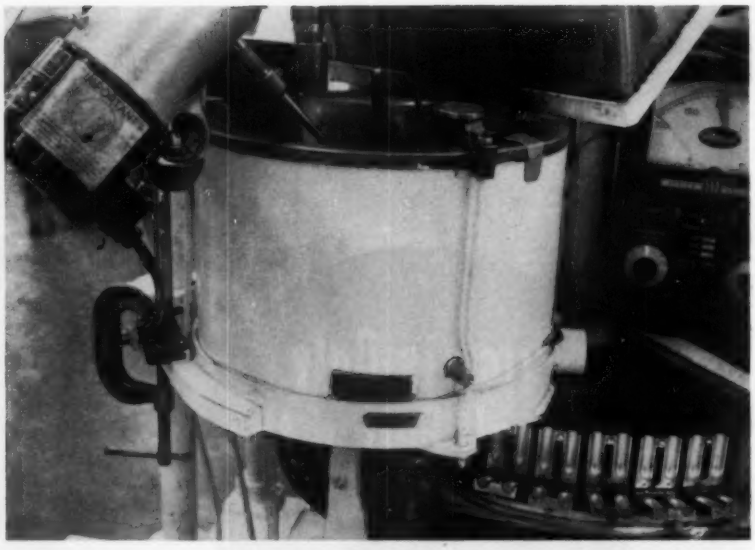
Typical applications include: Formulating solid rocket fuels, refractories, varnishes, plastics, food products, dry or liquid.

Write for new Bulletin 14

W & C **WEIGHING & CONTROLS, INC.**
Div. of CompuDyne Corp.

E. County Line Road • Hatboro 12, Pa.

Circle 668 on Page 19



INJECTION molding of lipstick ingredients into final form is accomplished at high speed in this special machine at Avon Products Inc. Unit in foreground is a 10-quart electric heating kettle in which the raw materials are placed. The kettle, developed by Sta-Warm Electric Co., is equipped with thermostatic controls and an adjustable speed mixer to maintain the ingredients at the proper temperature and consistency for uniform molding. Two-cavity molds are shown in their opened positions at lower right.

charge of research, engineering, manufacturing, and sales of the Contract Mfg. Div., Machine Tools Div., and the Instruments and Systems Div. . . . **A. S. Burgoyne**, formerly vice president of manufacturing, named vice president and manager of the Press and Die Supply Div., E. W. Bliss Co. . . . **M. Frederick Jenny** joined Fischer & Porter Co. as a manager in the Systems Engineering Dept. . . . **Melvin D. Verson** elected president and chief operating officer of the Verson Allsteel Press Co. . . . **Harold G. Edwards Jr.** joined Telex Inc. as manager of manufacturing. . . . **James W. Hawthorne** elected vice president and appointed general manager of the Haydon Div., General Time Corp. . . . **Russ A. Henke** appointed director of research by Racine Hydraulics & Machinery Inc. . . . **Walter E. Gregg** elected vice president—technology for the Crucible Steel Co. of America. . . . **Herbert R. Reiss** named plant manager of the recently acquired New Rochelle facility of Precision Circuits Inc. . . . **Dr. William C. Leone** appointed vice president and general manager of the Electronics Div., Rheem Mfg. Co. . . . **John P. Hastings** named manager, field operations, Instrument Div., American Electronics Inc. . . . **Robert D. Lavin** appointed manager of the Systems Engineering Dept., Ortholog Div., Gulton Industries Inc. . . . **J. H. Hunnicutt** named applications engineer specializing in computer control and monitoring systems for the electric power industry at Thompson-Ramo-Wooldridge Products Co. . . . **P. G. Kayser** named manager and **Frank Oreskovich** appointed senior application engineer of the Heating and Cooling Coil Dept., Danville Div., Bohn Aluminum & Brass Corp. . . . **Alvin J. Jones** and **D. M. Hallier** elected vice presidents of Motch & Merryweather Machinery Co. . . . **Carl F. Graesser Jr.** appointed director of research at New Hampshire Ball Bearings Inc. . . . **Roswell W. Gilbert** named director of corporate research at Daystrom Inc. . . . **James L. Woodley** appointed manager-manufacturing of Hyster Co.

SPOTLIGHTING PLANTS

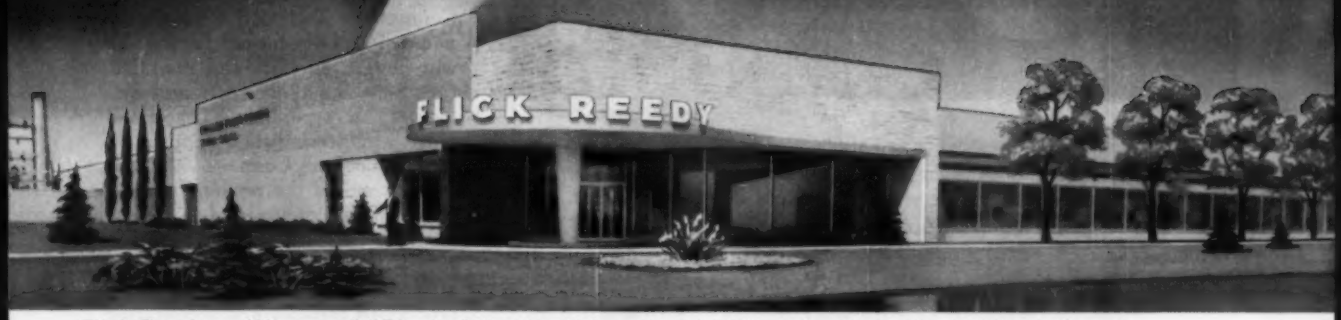
North Electric Co. has acquired control of Power Equipment Co., a producer of power supplies for computers and other electronic-electrical systems. The acquisition will retain its corporate name and will operate as a subsidiary of North Electric

OPENING NEW HORIZONS

. . . in economical power application

98% PLUS OPERATING EFFICIENCY
MORE POWER PER CYLINDER DOLLAR
PROVEN LEAKPROOF OPERATION
GREATEST SELECTION EVER OFFERED
SAFE UNDER SEVERE LOADS
SAFE WITH ALL KNOWN HYDRAULIC FLUIDS
SAFE UNDER TEMPERATURE EXTREMES
DAMAGE-PROOF PISTON RODS

Miller HYDRAULIC CYLINDERS



Flick-Reedy . . . *Winner of "Plant of the Year" Award and "Silver Anvil" Public Relations Award*

Miller

MORE SAVINGS!

Our ultra-modern, new "Plant of the Year" with its special facilities and operating economies enable us to offer an **extra 10% price savings** on our big "stock" selection of:
Model "H" (Hyd.) Cylinders, 1½" through 8" bores;
Model "J" (Hyd.) Cylinders, 1½" through 14" bores;
Model "A" (Air) Cylinders, 1½" through 14" bores.
Strokes up to 36", cushioned and non-cushioned.

Full Details On Request

Miller Hydraulic Cylinders make impossible applications look easy. With Teflon Seals, Case-Hardened Rods (50-54 Rockwell C), Patented "Shef" Tubing End Seals, and other exclusive *standard* features, these cylinders are practically damage-proof, are ultra-dependable under pressure and temperature extremes, and provide leakproof sealing with ALL hydraulic fluids. Built to *exceed* J. I. C. Specifications, these cylinders are achieving new highs in production and operating economies in thousands of plants. Two great lines: Power-Packed Model H for 3000-5000 psi and Job-Rated Model J for 500-2500 psi. All bores, strokes and mounting styles. Big "Stock" selection for immediate shipment at substantial savings.

Write for literature.

R

MILLER FLUID POWER

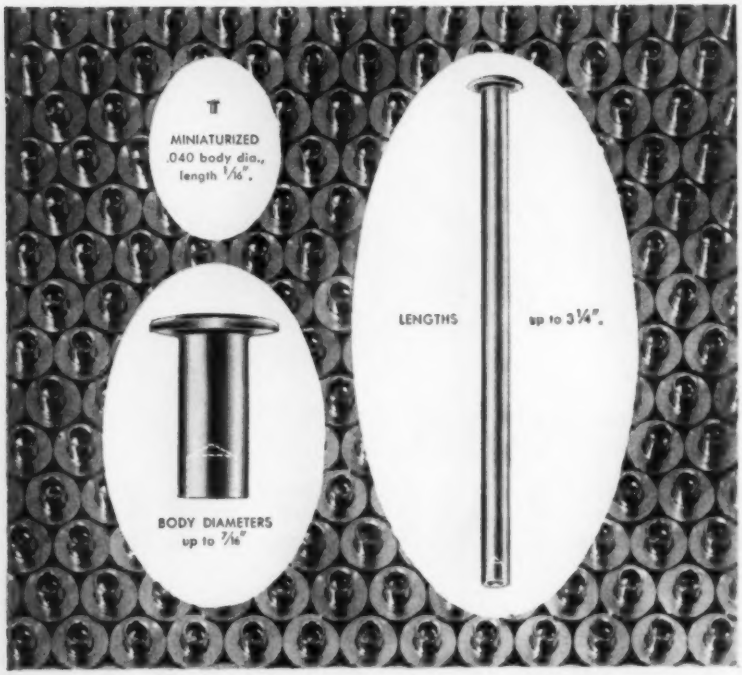
DIVISION OF FLICK-REEDY CORPORATION

7NO26 York Road, Bensenville, Illinois

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Circle 669 on Page 19

Look at this Size Range of Semi-Tubular Rivets... it's the way to lower cost



Miniaturized components and also large complete assemblies can now have all the money-saving advantages of using single and multiple automatic riveting. This is due to the wider size range of semi-tubular rivets now available and which can be used in conjunction with motor and pneumatic driven automatic riveting machines.

Today, there is hardly a fastening problem, involving even fragile materials, that does not warrant consideration of low-cost semi-tubular rivet setting.

Our Factory Riveting Specialists are ready to help you obtain the REAL COST FACTS on your own specific fastening problem. There is no obligation.

FOR YOUR FILES

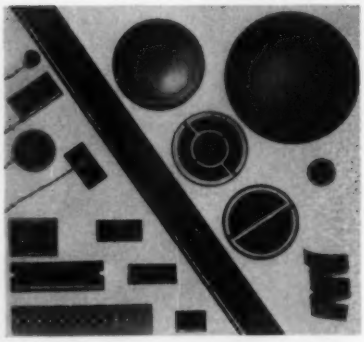
Chicago Rivet Catalog describes 1388 standard tubular and split rivets and 25 single and multiple automatic rivet setters.

AIR-POWERED RIVETING

contains description and specifications of 8 single, multiple riveters— also rivet setters designed for automated operation.

Chicago Rivet & MACHINE CO.

943 So. 25th Ave., Bellwood, Ill. (Chicago Suburb)
Branch Factory: Tyrone, Pa.



MANUFACTURING process developed by Weston Instruments Div., Daystrom Inc., enables fabrication of selenium photoelectric cells in various configurations to suit specialized applications. Forms include spheres, cylinders, and flexible strips that may be twisted into spiral shapes. With design flexibility thus afforded, several simplifications can be effected. For example, a convex shape can respond to light from all directions without optical equipment, and a concave shape will give highly directional readings. Curved or spiral shape cells can be used as function generators, speed measuring devices, or to provide On-Off action.

Co., telecommunications and automatic control manufacturer. . . . **Connecticut Technical Corp.** is the name of a newly formed firm which will design, develop, and manufacture data handling units and systems. The corporation has acquired office, engineering, and shop facilities in Hartford, Conn. . . . **Crane Co.** has moved the production facilities and headquarters of its Swartwout Div. from Cleveland to Hooksett, N. H. The move is one phase of a program aimed at increasing production capacity and accelerating product development activities. . . . **American Machine & Foundry Co.** has acquired Cuno Engineering Corp., manufacturer of industrial filters. The acquisition will round out and expand AMF's position in the water purification and liquid conditioning fields. . . . **Bausch & Lomb Inc.** is the new name of the former Bausch & Lomb Optical Co. The change in corporate identity recognizes the fact that B&L is not restricting its research and manufacturing interests to the field of optics alone, but is moving into related fields such as radiation measurement and electronics. . . . **Stelron Cam Co.** is the name of a new company formed in Hackensack, N. J., which will manufacture quality precision cams. . . . **General**

WHICH JOB WOULD YOU TAKE?

If you're like most of us, you'd take the job with the more tempting salary and the brighter future.

Many college teachers are faced with this kind of decision year after year. In fact, many of them are virtually bombarded with tempting offers from business and industry. And each year many of them, dedicated but discouraged, leave the campus for jobs that pay fair, competitive salaries.

Can you blame them?

These men are not opportunists. Most of them would do anything in their power to continue to teach. But with families to feed and clothe and educate, they just can't make a go of it. They are virtually *forced* into better paying fields.

In the face of this growing teacher shortage, college applications are expected to *double* within ten years.

At the rate we are going, we will soon have a very real crisis on our hands.

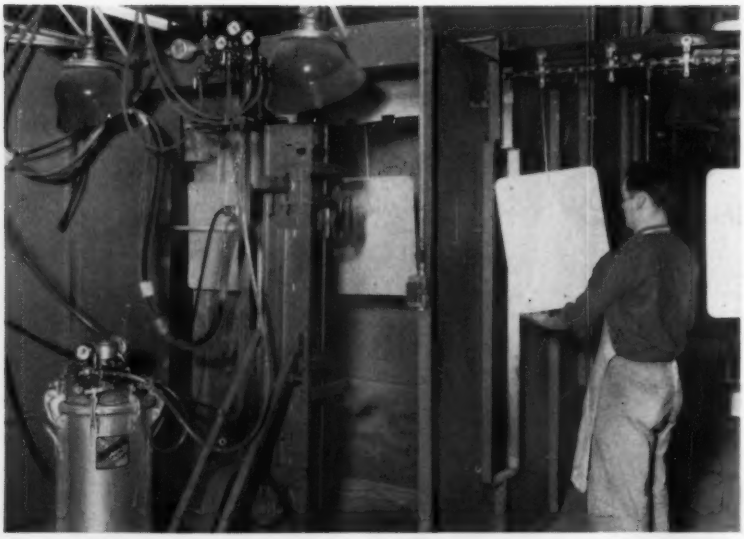
We *must* reverse this disastrous trend. You can help. Support the college of your choice today. Help it to expand its facilities and to pay teachers the salaries they deserve. Our whole future as a nation may depend on it.

It's important for you to know more about what the impending college crisis means to you. Write for a free booklet to: HIGHER EDUCATION, Box 36, Times Square Station, New York 36, N.Y.

ADVERTISING COUNCIL PUBLIC SERVICE

Sponsored as a public service,
in co-operation with the Council for Financial Aid to Education

HIGHER EDUCATION
KEEP IT BRIGHT



Chicago's Sign Division

cuts painting time from 2 days to 1 hour

"With our old equipment and air dry paints, it took us two days to paint a sign. With Binks automatic spraying system and drying ovens, we now do the same job in only 1 hour," states Mr. Don R. Crowell, City of Chicago Traffic Engineer.

Quality finish boosts sign life

Until Binks equipment was installed, many of the 100,000 signs produced each year had to be farmed out. Now all signs are painted in the Sign Division shop. Quality has been improved, too, since sign life is now about six years as against two years when painted by previous manual spray methods.

Saves time and paint

Besides a great savings in time, the new Binks system saves money by cutting the amount of paint needed through reduction of overspray. Although present production is 100,000 signs per year, the new Binks system can turn out up to 250,000 signs . . . an ample allowance for future growth needs.

Free planning service

If you have a spray finishing problem, it will pay you to consult a Binks spray finishing engineer. He will show you how a Binks integrated spray system can speed up finishing and give you better quality at lower cost. For an appointment call your nearest Binks office or write direct.

Ask for Bulletin 975 . . . describes spray finishing equipment, methods and systems.

Ask about our spray painting school
Open to all...NO TUITION...covers all phases

0577

Binks
EVERYTHING FOR
SPRAY PAINTING

SPRAY GUNS

AIR COMPRESSORS

NATIONWIDE SERVICE

Binks Manufacturing Company
3132-40 Carroll Avenue, Chicago 12, Illinois

REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

Circle 672 on Page 19

Precision Equipment Corp. is combining operations of GPE Controls Inc., a subsidiary, with those of General Precision Inc., its principal subsidiary. Under the new arrangement, GPE Controls will become a wholly-owned subsidiary of General Precision Inc. and will be under the operating direction of the Link Division of the principal subsidiary.

MEETINGS AND EVENTS

June 25-July 9—

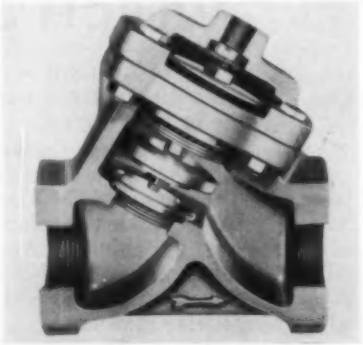
International Federation of Automatic Control. First International Congress to be held Moscow State University, Moscow, USSR. Information is available from Eugene Grabbe, P.O. Box 45067, Airport Station, Los Angeles 45, Calif.

July 2-6—

National Tool & Die Manufacturers Association. Summer meeting planned for Banff Springs Hotel, Banff, Alberta. For details contact association headquarters, 907 Public Square Bldg., Cleveland 13, Ohio.

July 7-8—

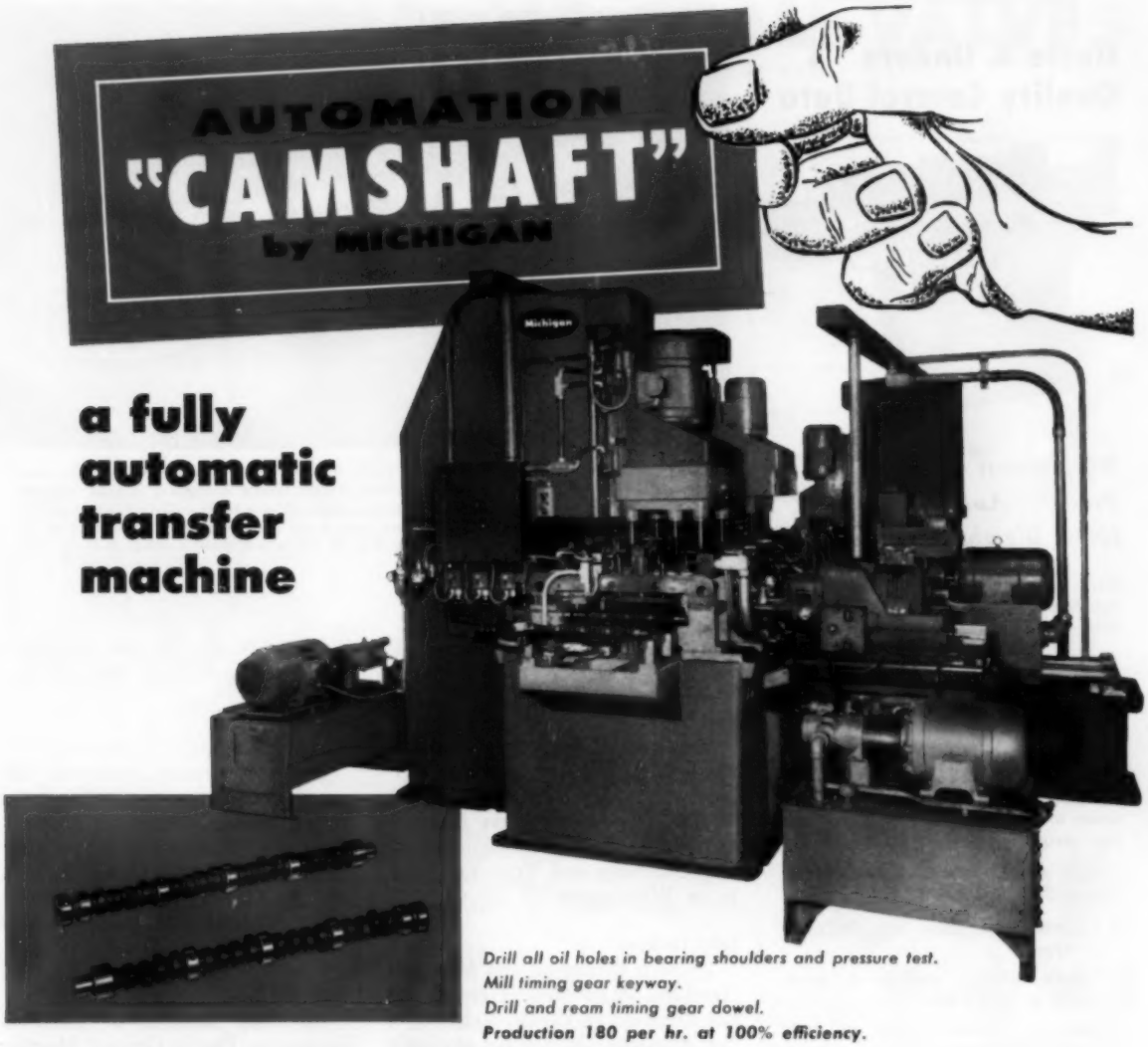
Seminar on Low-Cost Automation. To be held Pennsylvania State University, University Park, Pa. Additional information available from Conference Center, Pennsylvania



DIAPHRAGM valve developed by Aqua-Matic Inc. has positive opening and closing action without the use of springs or auxiliary external forces. In closing, line pressure applied above a diaphragm at the top of the unit closes a disc against a seat because the area of the diaphragm is greater than that of the disc. To open the valve, pressure is relieved above the diaphragm, and line pressure against the disc lifts this member to its uppermost position. A feature of the valve is easy replacement of all working parts by removing a cap at the top of the unit.

AUTOMATION "CAMSHAFT" by MICHIGAN

a fully automatic transfer machine



Drill all oil holes in bearing shoulders and pressure test.
Mill timing gear keyway.
Drill and ream timing gear dowel.
Production 180 per hr. at 100% efficiency.

it provides a complete oil system in 20 operations!

The first 3 operations are performed in the initial radial position; the next 7 operations, after indexing the camshaft 46°; and the last 10 operations, after indexing the camshaft an additional 115°.

it's compact automation — for limited floor space!

It's a 12-station Transfer Machine, designed for a production line operation — And, it will fit in a floor space of only 14' x 22'.

it's fully automatic — including load and unload!

All the components, as well as the transfer, locating, and clamping mechanisms, are hydraulically operated and electrically controlled.

and, it's built around standard michigan components!

You'll enjoy substantial savings in machine cost, too, because it's built, fully 70%, from our own Standard Michigan Components.

for faster, More Economical Production

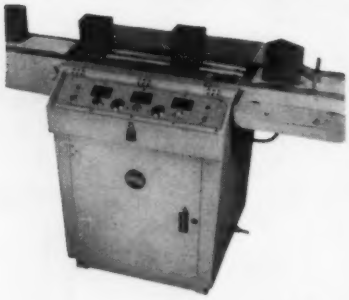
Michigan SPECIAL MACHINE CO.

Engineers and Manufacturers of High Production Metal Cutting Machines and Components.

11449 TIMKEN AVE., WARREN, MICHIGAN

Circle 673 on Page 19

Overs & Unders Quality Control Data



Wrightronic® Checkweigher Provides Automatic 100% Weight Inspection

Here is the sure, automatic answer to tightening Weights & Measures regulations and costly product give-away.

As packaging line equipment, the Wrightronic Checkweigher can be used to reject packages over or under acceptable weights.

As a quality control instrument, the Wrightronic Checkweigher provides exact data on accuracies and makes it easier to spot necessary adjustments to your weighing-filling equipment.

This modestly priced, thoroughly proven checkweigher:

- Electronically gross weighs each package.
- Signals whether package is over, under, or on weight.
- Registers running count in each weight classification.
- Rejects, if desired, any package outside acceptable limits.

Normal operating speed is 100 to 120 per minute, depending upon product and package. Range: 3 ounces to 5 pounds.

WRIGHT MACHINERY COMPANY
DIVISION OF SPERRY RAND CORPORATION
DURHAM, NORTH CAROLINA

Gentlemen: Please send me details, including price and delivery information on your Wrightronic Checkweigher.

Name .....
Company .....
.....
Address .....
City ..... State ..... (A)

Circle 674 on Page 19

VACUUM lifting device developed by Vac-U-Lift Co., Div., Siegler Corp., is designed especially to transfer hot (700F) aluminum liners from a moving conveyor to a stack. Operating cycle is 18 seconds for the hydraulically operated, overhead track unit. Six vacuum pads attached to a 15-foot long beam are used to lift the 16-foot long by 6-foot wide by 3-inch thick liners. Special seal rings are used in the vacuum pads to adapt them for high temperature service.

State University, University Park, Pa.

July 18-20—

Southern States Apprenticeship Conference. 12th Annual Conference scheduled for Everglades Hotel, Miami, Fla. Information is available from U. S. Department of Apprenticeship and Training, locally or Washington 25, D. C.

July 19-21—

Western Packaging and Materials Handling Exposition. Planned for Los Angeles Pan Pacific Auditorium, Los Angeles. Details are available from exposition offices, 759 Monadnock Bldg., San Francisco 5, Calif.

July 22-24—

National Association of Metal Finishers. Annual meeting to be held Statler-Hilton Hotel, Los Angeles. For more information contact association headquarters, 60 Bently Rd., Cedar Grove, N. J.

July 24-28—

American Electroplaters Society. Annual meeting scheduled for Statler-Hilton Hotel, Los Angeles. Further information available from society headquarters, 445 Broad St., Newark 2, N. J.

Aug. 1-5—

Gordon Research Conferences. Instrumentation conference to be held Colby Junior College, New London, N. H. For details contact Colby Junior College, New London, N. H.

Aug. 7-13—

Eleventh Annual Industrial Research Conference. Scheduled for Arden House, Harriman Campus, Columbia University, New York. Further information available from M. F. Garvey, 409 Engineering Bldg., Columbia University, New York 27, N. Y.

Aug. 8-12—

American Institute of Electrical Engineers. Pacific General Meeting to be held El Cortez Hotel, San Diego, Calif. For details contact institute headquarters, 33 West 39th St., New York 18, N. Y.

"Here are the drawings for our new miniature diode."

BARKSDALE AIR-SEAL* VALVES

LOW PRESSURE AIR TO 250 P.S.I.

. . . over 200 different valves available.

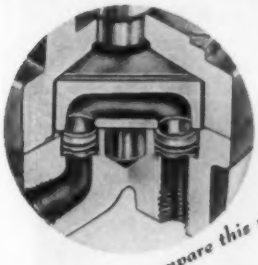
**The air pressure is the sealing force . . . the higher the pressure, the tighter the seal.*

Why so many different air valves?

Because air valve requirements vary with the method of actuation. A basic valve with interchangeable actuators cannot possibly meet ALL your specific applications without compromise. For example: A solenoid valve designed for speed would not have the stamina required of a manual or foot valve.

The Barksdale line of AIR-SEAL Valves has been designed with your requirements in mind. All our valves have been engineered for best performance from your point of view . . . for YOUR specific need, and not to make OUR job easier.

MANUAL and FOOT OPERATED "SHEAR-SEAL" VALVES



No oilers and filters needed — not critical to dirt and corrosion — made from non-corrosive materials.

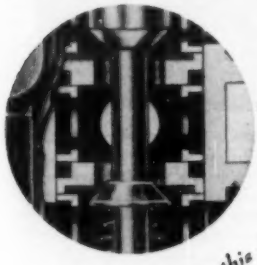
Years of leakproof service — without constant maintenance — Self aligning "Shear-Seal" design compensates for normal wear.

compare this with conventional SPOOL or PLATE VALVES

Alignment is critical — dirt and corrosion cause sticking.

There is no compensation for normal wear — leakage increases with use.

SOLENOID-PILOT CRESCENT® (Self-aligning poppet) VALVES



Quick response (12 milliseconds) due to short travel of poppets and solenoid.

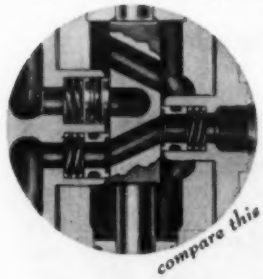
Tight sealing — self-aligning, self-scavenging design adjusts to normal wear — not critical to dirt and corrosion — non-corrosive materials throughout.

No coil burnout — heat dissipating "integral" design.

compare this with conventional SPOOL VALVES

Slower response due to long spool travel. Leakage increases with use — dirt and corrosion particles are ground-in between spool and seals—Sticking! Overheating causes coil burnout — poor heat transfer of "unitized" design.

DIRECT-SOLENOID OPERATED "SHEAR-SEAL" VALVES



Leakproof for years of service — self-adjusting to wear. No coil burnout — because valve does not freeze up.

compare this with conventional SPOOL VALVES

Dirt enters spool clearances — develops leaks — causes sticking — sticky valves are to blame for most solenoid burnout.

Write for Air Valve Catalog 9-AV

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

MANUALLY OPERATED

4-Way valves ¼ to 1½" N.P.T. with or without spring return

Shut-off valves ¼ to 1" N.P.T. with or without spring return

FOOT OPERATED

4-Way valves ¼, ⅜ and ½" N.P.T. with or without spring return

SOLENOID-PILOT

4-Way valves ⅛ to ¾" N.P.T. A.C. and D.C. Standard

Explosion-proof

J.I.C. type

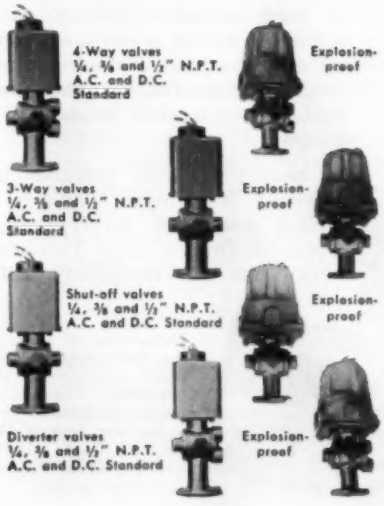
With manual override

3-Way valves ¼ to ¾" N.P.T. A.C. and D.C. Standard

With manual override

Explosion-proof

DIRECT SOLENOID



4-Way valves ¼, ⅜ and ½" N.P.T. A.C. and D.C. Standard

Explosion-proof

3-Way valves ¼, ⅜ and ½" N.P.T. A.C. and D.C. Standard

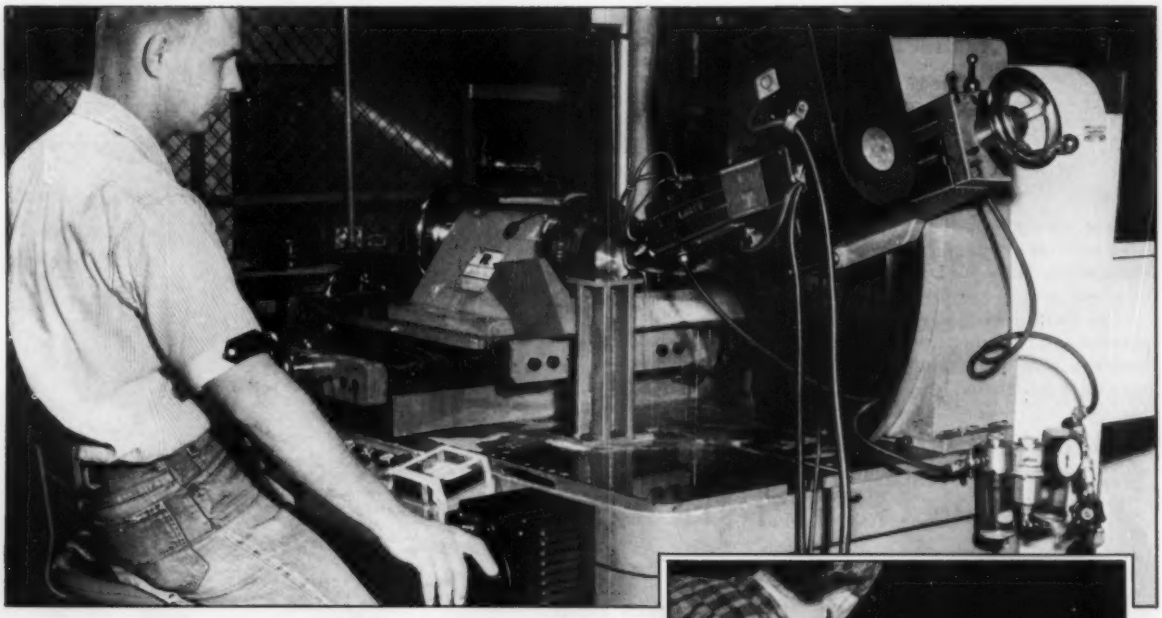
Explosion-proof

Shut-off valves ¼, ⅜ and ½" N.P.T. A.C. and D.C. Standard

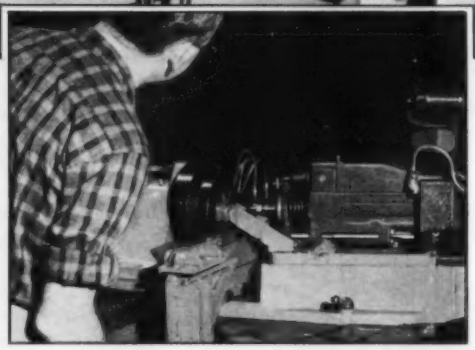
Explosion-proof

Diverter valves ¼, ⅜ and ½" N.P.T. A.C. and D.C. Standard

Explosion-proof



This special machine at Rocketdyne is designed so that angular adjustments of Bellows-Locke Drilling unit can be made in a vertical plane. Also visible is the Bellows Lubri-Air® Control unit (right) which cleans, lubricates and regulates the air supply.



This machine is similar to the one in the main illustration, except that the Bellows-Locke Drilling unit is mounted in a horizontal plane. Work-holding fixture also indexes on horizontal axis. Between the two machines, any angular relationship between two or more holes can be produced.

BELLOWS-LOCKE "Packaged" DRILLING UNITS

PROVIDE A DOWN-TO-EARTH SOLUTION FOR ROCKETDYNE'S SPACE-AGE PROBLEM

One of the most critical components of a liquid-propellant missile propulsion system is the fuel injector head, containing hundreds of very small holes, each of which must be highly accurate not only as to shape and size but also as to location, angle and finish. Because Rocketdyne, a Division of North American Aviation, Inc., is deeply involved in missile propulsion, both in the experimental phase and in the manufacture of engines which have reached the production stage, it must produce fuel injector heads in a wide variety of designs.

To meet the special demands of accuracy and flexibility, Rocketdyne engineers designed special drilling machines, incorporating Bellows-Locke Model 5-E Drilling units. These compact, versatile work units are completely self-contained, will operate at any angle in any plane, and feature a built-in valve controlling an adjustable air powered rapid advance and retract as well as an adjustable, precision hydraulic feed.

With the Bellows-Locke Drilling units, Rocketdyne holds tolerances to ± 0.0005 inch on holes less than 0.080 inch in diameter, while on holes that size and larger tolerances are held to ± 0.001. Center distances between holes are held to ± 0.003 inch. Commonly, two holes are drilled at an angle to intercept a vertical hole at a given point. The tolerance on this intercept is ± 0.001 inch and is held readily with the Bellows-Locke units.

Thousands of users have found the Bellows-Locke Model 5-E the ideal solution to their drilling problems. Chances are it can prove valuable to you, too. Write today for free Bulletin BL-5RA. Address Dept. AU-760, Bellows-Valvair, Akron 9, Ohio.

Bellows-Valvair

The Bellows Co. • Valvair Corp. Akron 9, Ohio

DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

784-C

By JAMES C. KEEBLER Managing Editor

Moderators for the Fourth Production Machine Tool Hydraulic Forum held in Detroit were (left) Nevin Bean, staff technical assistant Automatic Transmission Div., Ford Motor Co.; and (right) R. C. Montanus, president, Springfield Machine Tool Co. Bean has been with Ford 40 years, is a fellow in ASME and admits to the distinction of being the first to present a paper on automation at a technical society meeting. Montanus was a Revision Group Chairman of the ASTME Handbook and has been supplying lathes (and lately vertical grinders) to industry since graduating from Purdue in '32.

Living with It

TODAY the organizational structures of the auto industry place responsibility for production equipment specification squarely on the heads of those engineers assigned to the manufacturing engineering function. "Specification" is a broad term and its practical boundaries are becoming broader as the automakers dig deeper into the causes of some of their downtime headaches.

Whose Design?

The manufacturing engineer is learning that he must not only specify the sequence of production operations, the type of equipment to perform each operation, but he must also write rather complete design specs on the equipment he buys. This puts our boy into the role of equipment design, and prompts the oft spoken jab at commercial equipment designers: "You may think you've designed a good machine but don't forget—*we've* got to live with it." If things work well there may be a halo polishing contest that would make it difficult to determine who did actually conceive and design the new equipment, but in any event the bird who bought it usually has to answer for any shortcomings that develop.

Automating automakers know that *good* design goes beyond merely designing an arrangement that works, and enters the realm of designing for the rigors of long-run production service. Minimum downtime involves not only reliability assurance that the probability of failure is low, but also includes provision for ease of servicing so that production can be quickly restored in short order.

Two proposals for an automated machine might differ markedly in price because they represent different standards of performance. To protect his company from biting on a low bid and getting something unpalatable, the manufacturing engineer that's going to have to live with the equipment must have complete enough specifications to know that all proposals will be for machinery of the same range of quality and feature the same "extras" that make for trouble-free life.

Specification Requirements

Specs against which equipment suppliers must bid should spell out features that make the equipment inherently reliable, features incorporated specifically for the purpose of helping the troubleshooter even though not required for the simple functioning of the equipment, fail-safe requirements, and list any additional information, instructions, and diagrams that are to be supplied for the purposes of facilitating operation and maintenance of the equipment.

At the Vickers' Fourth Production Machine Tool Hydraulic Conference held in Detroit about a half hundred automakers got together with a like number of machine tool builders, a few control makers, and the Vickers people to discuss (with the aid of a complex of microphones and tape recorders) how to improve hydraulic products, systems design, and maintenance.

This is one area where the users are already pretty far along in specifying equipment design criteria. The J.I.C. standards for hydraulics say what is expected by the automakers. The machine tool builders note that their industry has shown a general acceptance of J.I.C. on special machines, but that their standard lines are still nonconforming, however, many are slowly undergoing redesign and adopting these standards. R. C. Montanus, one of the moderators of the Conference and president of the Springfield Machine Tool Co., observed that the J.I.C. standards were brought about by trouble in the users' plants and that his company thinks only in one way, i.e. go J.I.C. all the way.

Practical Experience

Although many circuits were discussed that use accumulators, Robert Guy of Detroit Transmission Div., General Motors, cautioned that the use of accumulators can be danger-

ous because they represent a stored source of pressure that can actuate parts of the circuit even though the pump may be off. When his equipment is in the condition of *Emergency Stop,* Guy wants to be assured that no action will take place. Martin Friedland of Wiedemann Machine Co. indicated that they use a "blocking valve" in their accumulator circuits to stop action when required.

Use of fire resistant fluids is a point of principal concern to the user. J. Russel Hemeon of Ternstedt Div., General Motors, said their management requires that every hydraulically operated machine use fire resistant fluid. One of the design-for-reliability ideas he stresses is the use of magnetic plugs in the sumps of hydraulic tanks. These help keep the fluid clean by trapping micronic particles that get through the filter in the system. Various fluids were discussed including phosphate esters, silicones, water glycol, and inverse emulsion. The system designer's specs must indicate the fluid, for no seal material currently used is effective for all the variety of fluids presently available. Ford's D. Holloway from Yipsilanti warned that there is considerable difference in water-based fluids, and advised staying with a reputable firm and not letting the accountant specify hydraulic fluid.

Drip Drip

No such gathering can long endure without discussing leaks. Frank Fiedler of Chevrolet-Buffalo gave a prepared paper on their preventive maintenance system, and documented their "Red Tag Procedure." When an oiler finds a machine using an excessive amount of oil he writes it up on a red tag, half of which goes to the production foreman for hanging on the machine and half of which goes to the machine repair general foreman. The production foreman writes a request for repairs stating when the repair can be made. By expediting, cross checking tickets, and watching out for *repeaters*, the machine repair department has been able to reduce oil consumption from over 9000 gallons per month to between 7000 and 8000.

In years gone by one of the proved solutions to the problem of leaks was the use of SAE straight thread fittings with "O"-ring seals. Vickers' report indicates that only 0.1 per cent of 1959 sales called for straight threads. The industry knows they are better but they don't buy them. F. L. Mackin of General Motors Institute attributes this to the old inventory bug. It would take sweeping managerial orders to change over. He suspects automakers are spending more for lost oil than conversion would cost.

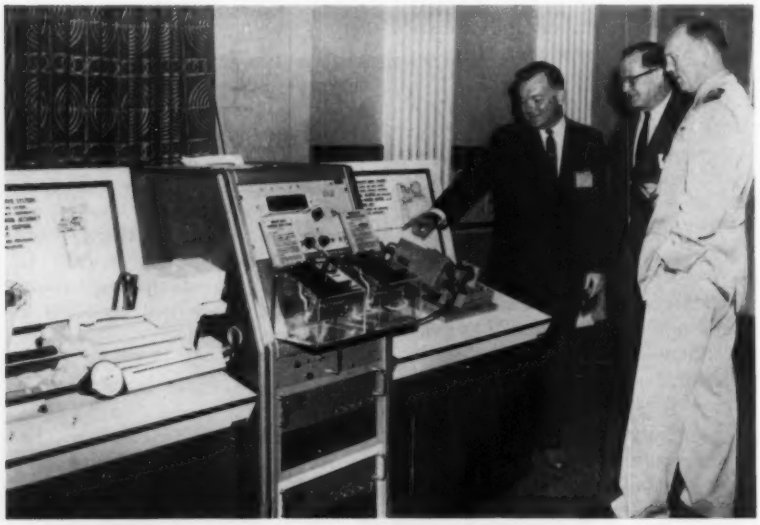
Clashing Tradesmen

Another thing that's bugging the maintenance man is what's known as *trade clash.* When a machine repairman comes to fix a hydraulic problem and must disconnect a solenoid valve he may have to get an electrician on the job just to disconnect a couple wires. Guy of Detroit Transmission suggests that solenoid operated valves be wired such that electrical cables terminate in a plug which could be disconnected without waiting for an electrician.

Fiedler tells of a similar problem with lubrication systems: "We like pressure switch controls on lubrication systems but when a machine already has one, or when we install one, we always install a pressure gage marked high and low limit with a shut-off. This is done for this reason—when a machine stops, the production foreman calls an electrician who comes on the job and checks. He often finds that the pressure switch is not made, and doesn't know if the pressure is low or if he has a faulty switch. So he calls for a repairman who also comes on the job. Then the age-old battle begins. Each accuses the other. When a gage marked high and low limit is on the job, the electrician has only to open the shut-off valve, and has no need for a repairman."

Not all auto plants indicate that this trade clash problem is of serious proportions, but certainly any delay in locating and correcting trouble is a costly thing on automated equipment. Designers of components and equipment must take into account the whole range of practical aspects relating to equipment use, and design around all bottlenecks even though created by the members of the organization who are supposed to shoot trouble, not cause it.

Electrohydraulic servo systems are coming of age. A whole afternoon of the Conference was devoted to this subject. Will companies be able to train maintenance men of the present trade classes to keep this equipment running, or will new classes be established? Automation is here; those who are living with it still have some challenges.



Explaining Vickers' building-block electrohydraulic servo system demonstration stand is (left) A. Van Wormer sales manager of Industrial Products, Vickers Inc. Conference moderator R. C. Montanus and conferee Cdr. Leonard L. Brannon look on. Cdr. Brannan is from the Navy Production Equipment Control Office in Washington.

Teletype Model 28 punched tape units

The Teletype Model 28 tape reader and typing tape punch combine proved dependability of operation with a variety of features which help streamline data communications systems and save the time of attendant personnel.

• *Convenience.* On the Model 28 tape reader, a single 3-position start-stop lever controls "on," "off," and "freewheeling." A specially designed tape lid, conveniently hinged, will accommodate either chadless tape or fully perforated tape, without intermediate adjustment.

The Model 28 tape punch not only perforates intelligence into tape—it simultaneously "prints out" the data right on the tape, thus greatly facilitating handling and storage.

• *Low Maintenance.* Both units are designed for extremely low maintenance, with all-metal clutches that require oiling only once or twice a year, depending on usage.

• *Reliability.* Teletype tape equipment is the product of extensive research and precision manufacturing facilities. It is made for continuous, day-in, day-out service with minimum upkeep. Teletype Corporation manufactures this equipment for the Bell System and others who require the utmost reliability from their data communications systems.

Circle 677 on Page 19

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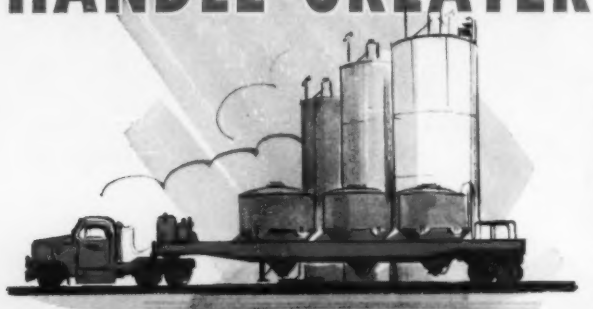

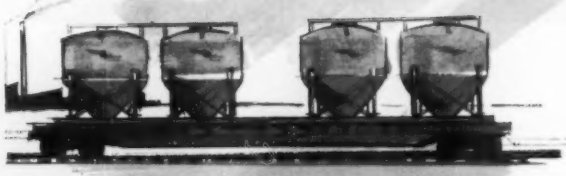

Since 1940, Halliburton has led the way in the development of more efficient equipment specifically designed to handle all types of bulk materials.

The system originated as a result of Halliburton's world-wide services with bulk cement for oilfield use in onshore and offshore operations.

The experience, techniques and knowledge gained over the years has led to applications of these advanced pneumatic mobile and stationary systems capable of handling a wide variety of finely divided, free-flowing materials, bulk chemicals and other materials including those in pelletized form. Bulk materials are pneumatically discharged from the bulk handling equipment.

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Halliburton Pneumatic Bulk Material Handling Equipment is designed for materials ranging from 16 to 165 lbs. per cu. ft. – conveying them from 0 to 100 cu. ft. per minute at distances varying from 0 to 1,400 feet and with as much as a 100 foot rise. Systems of greater capacities and distances are custom engineered.

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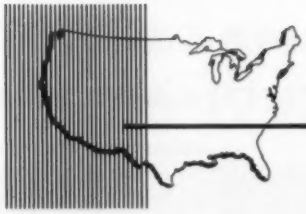


western trends

Construction equipment that lays "instant concrete pipe" in a freshly-cut ditch at the rate of eight to twelve feet per minute has been developed by the Fullerform Continuous Pipe Corp. The equipment consists of a double-hoppered forming machine, shown above, which receives concrete from ready-mix trucks and compacts it around an inflatable inner form. After about two hours, the inner form can be deflated and pulled from the newly-laid pipe. Various models of the equipment can lay pipe ranging in diameter from 12 to 48 inches.

Integrated Pipe Laying

ALTHOUGH its successes are not as spectacular as successes reported by the manufacturing industries, the construction industry is attempting to automate its operations wherever it can. This is not to say that automation *en masse* is just around the corner or can be expected in the near future, but certain construction areas are showing evidence of trying new methods and equipment to do old jobs.

For example, in Phoenix, Ariz., the Fullerform Continuous Pipe Corp. has developed a new process in which concrete conduits for irrigation water are built in a shaped trench at a rate of eight to twelve feet per minute. In addition to cutting construction time and over-all costs, the process eliminates seams and joints in the pipe and makes possible continuous pipe runs of several miles in length.

The equipment used in the process consists of a double-hoppered forming machine which forms the outside wall of the pipe, a hose-like inflatable form which supports the inner wall of the pipe, and a winch unit which pulls the forming machine along the trench. At the present time, equipment is available to lay pipe ranging from 12 inches to 48 inches in diameter, and the company is developing equipment to lay a 60-inch diameter pipe.

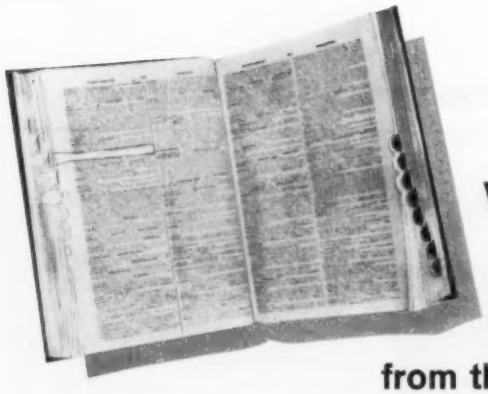
In operation, a trenching machine first cuts a trench, with a rounded bottom, that is the length of an inflatable form. Then the forming machine is placed in the trench, and one end of the inflatable form is passed through the unit and secured to the end of the trench. After the inner form is inflated to a pressure of 3 psi, the pipe-laying process begins. Concrete is poured into the double-hoppered forming machine from ready-mix trucks driving parallel to the trench. Electrically driven tamping devices force the concrete from half of the double hopper into the bottom of the trench while the upper hopper is forming the top of the pipe.

About two hours after the pipe has been poured, the inner form can be deflated and removed. This makes it possible to use the same inner form several times a day. Although the first commercial applications of the process have been limited to making irrigation pipe, the company feels that the process can be applied in laying storm and sanitary sewer pipes.

The inflatable forms have been made in lengths varying from 50 feet to 300 feet by the Goodyear Aircraft Corp. Using two 300-foot inflated forms, as much as 600 feet of concrete pipe can be poured at a time without interruption. Tests have shown that the conduit would meet the Bureau of Reclamation standards for the state of Arizona. Samples tested have exceeded weight-test requirements by four tons and compression strength by 520 psi.

Laying Aluminum Pipe

Another example of integrated pipe laying occurred at Denver, Colo.—only this time the pipe was aluminum and not concrete. The Aluminum Co. of America demonstrated a new technique for laying small diameter pipe at a rate of



WHO cut out WHAT word from the dictionary?

im-pos"si-bil'i-ty, *n.* [-TIES, *pl.*] **1.** The fact or state of being impossible. **2.** That which is impossible; something that can not exist or be done.—**im-pos'si-bly,** *adv.*

THESE **are the men who cut it out:**

. . . part of the staff of Automation Engineering Laboratory, Incorporated . . . engineers, designers, inventors . . . yes, even dreamers. They have consistently solved "unsolvable" manufacturing, handling or processing problems . . . have designed and built "impossible" machines . . . that worked! They have done this for companies among the top five in such varied fields as Automotive, Electrical, Food, Paper, Textiles . . . etc.

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Whatever your automation problem, may we suggest you write or phone us? One of us will visit you . . . listen carefully to your problem . . . gather information. After studying your over-all layout, he will go back to Stamford and share your problem with other AEL Senior Staff Members. What he will then tell you is *"We can do it!"* and . . . on a contract basis you will appreciate. Remember, the word "impossibility" has been cut out of our dictionary. Try us.

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approximately 3 miles per hour. In this system, an automatic pipe-laying machine digs a trench 42 inches deep, unreels and lays a 2-inch pipe, and backfills the trench, all in one continuous operation. The company reports that the installed cost of the aluminum pipe has been cut to nearly one-half of the installed cost of steel pipe used in the same application.

For the demonstration, thin-walled aluminum pipe, 2 inches in diameter, was extruded and coiled on a large reel at Alcoa's Lafayette, Ind., works. In the field, the reel of coiled pipe was mounted on a specially built trailer which was coupled to the pipe-laying machine. A short length of trench was first dug. Then the end of the pipe was fed to the pipe-laying machine, passed through a hollow plow blade on the machine, and anchored securely at one end of the trench. As a tractor pulled the trailer and pipe-laying machine across the field, the plow blade cut a 42-inch deep slit in the earth, the uncoiling pipe slipped through the blade and straightened out on the trench bottom, and the trench was backfilled by the machine.

When uncovered and inspected at the end of the test, the pipe proved to be in good condition. A section of the pipe, protected externally by tape, contained a welded joint which caused no difficulties during the operation. According to Alcoa, the equipment is capable of installing a continuous length of pipe up to one-mile in length. The pipe-laying method was developed by Alcoa and a major oil company in co-operation with the American Tractor Equipment Co., C. V. Miller Construction Co., and the Colorado Builders Supply Co.

Although these are only two isolated examples of operations being integrated in the construction industry, it can be said that automation is gradually making inroads into the industry. The problems to be surmounted are not easy because the nature of the business demands considerable manual effort of skilled and semiskilled workers. This industry needs automation for the same reasons that the manufacturing industries turned to automation —to cut cost, increase production, improve quality, and reduce scrap.

Circle 679 on Page 19

JONES & LAMSON "AUTOMATION"

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At The Goss Company, a division of Miehle-Goss-Dexter, Inc., Chicago, tape control machining plays an important part in the over-all production operation.

For instance, this J & L tape-controlled positioning table, equipped with a standard column drill press, has achieved an average of 30 to 40% savings in floor-to-floor time on every job assigned. One job, involving drilling and reaming of small malleable iron transfer roll adjusting plates, was transferred from a conventional sensitive drill press setup to the J & L machine. Job lots consisted of only four pieces.

The old setup required 3.1 hours production time for each lot. Using tape control, with a simple locating and clamping setup, Goss has been able to cut this time to 1.7 hours—a saving of 1.4 hours per lot, or more than 45%. Hole location is more accurate too, because J & L tape control consistently holds tolerances of + or — .001". With the old setup, it was difficult to hold hole locations to less than .010" on layout jobs of this size.

Investigate how *production-proven* tape control units can help increase the efficiency of *your* operation. Write to Jones & Lamson Machine Company, 536 Clinton Street, Springfield, Vermont for folder 5902, "Tape Control Positioning".

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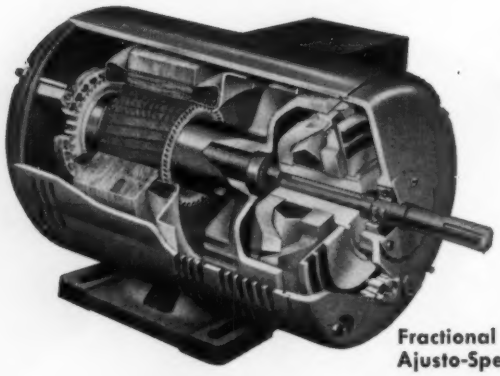

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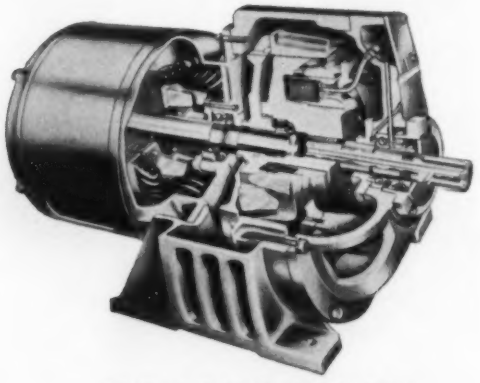

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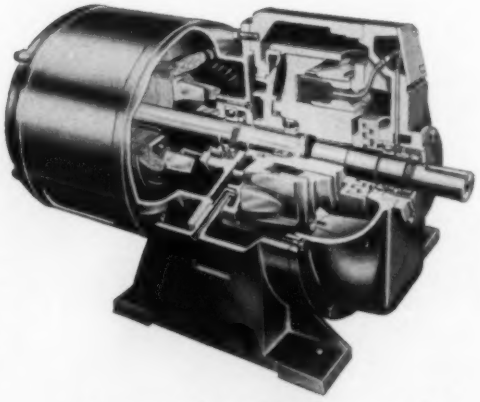

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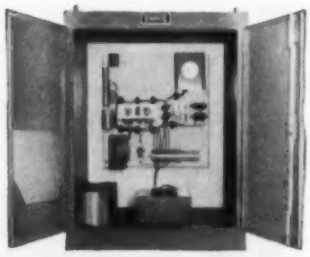

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Circle 681 on Page 19

Competition

Few debates among businessmen evoke more heated results than the presently popular one of foreign competition. Comments range from proposals for increased tariffs and disparaging remarks regarding cheap copies to waving of the good old red, white, and blue.

In the heat created there appears to be all too little light. Few constructive suggestions reach the light of day. The depressive result of overprotection is often overlooked. Failure to re-equip for increased efficiency and lack of innovation and manufacturing research seldom come in for serious consideration.

Yet here is the key. Research activity, manufacturing planning, and automation offer a realistic competitive edge more potent than any protective system. One of many recent reports detailed the impressive results obtained by a manufacturer of fishing tackle who followed this policy.

Foreign competition forced a decision to develop better product designs and to automate as much as possible to reduce costs. Increased sales could prevent loss of jobs. Research led to more automated machinery that reduced costs almost 25 per cent. Sales climbed 12 per cent, profits increased 12 per cent, and employment rose 20 per cent although volume in the industry as a whole declined.

The answer? Obviously an adaptive and developmental approach utilizing the latest in modern technology holds real promise under today's dynamic conditions. Similar conclusions outlined in a recent U.S. Foreign Policy Report prepared by Stanford Research Institute sum up the problem pointedly. Only by such a competitive dynamic policy can the economy remain secure against the shocks and pressures of the changing world economic trends.

PUBLISHER-EDITOR

AUTOMATION

GETTING A GRIP ON COSTS AND PAYOFF

By KARL H. MEYER
Manager, Manufacturing Services
Reliance Electric & Engineering Co., Cleveland, Ohio

GUARANTEES that investments in automated facilities will be financially sound are hard to come by. However, measures of a sound investment, the methods of gathering complete factual data, and some of the pitfalls to be avoided are discussed in this paper. Simple forms for summarizing and presenting pertinent information are shown, with a specific example of a successful proposal.

Financial analysts consider return on total assets employed in a business organized for profit to be the best of the measures of the success of that business and of the management of the enterprise. Return on total assets is the percentage relationship of the profit earned to the total assets employed, the assets being made up generally of cash, receivables, inventories, plant, property, and equipment.

Assuming acceptance of the soundness of return on investments as a measure of success of a total enterprise, it is logical to apply that measure to that segment of the business dealing with manufacturing. The ultimate objective, therefore, of any investment in manufacturing facilities being considered by a company organized for profit should be to obtain a satisfactory return on the investment involved. This is true whether that investment is in a very simple manually controlled machine or a complex, highly automated manufacturing line. In general, the objective for return on investment should be such as to result in an over-all increase in the return on all assets being employed in the business.

These broad objectives and measure of results are likely to be readily accepted. Problems, though, immediately manifest themselves when all of the facets of any but the simplest specific potential investment are to be considered.

The capital expenditure analyst is faced with a wide array of: Forecasts such as production volume, life expectancy of the product line, life expectancy of specific parts of the line, and life expectancy of the equipment under consideration; proposals covering various approaches, equipment, and processes; quotations for equipment covering all or part of the total required; estimates and guesstimates on costs and savings all the way from A to ZZ; inflation or deflation; tax considerations; etc.

Even if it could be assumed that the analyst could achieve perfect answers to all of the elements just mentioned, and thus arrive at a mathematically and factually correct return on the proposed investment, the question still could remain as to whether the investment would result in an over-all increase or decrease in the corporate return on investment. This is because few, if any, can know for sure the proportionate contribution to the over-all return on investment that is currently being earned by any one piece or group of manufacturing facilities. The earnings bogey for the proposed equipment must therefore be an estimate, not a mathematically assured value.

Aids To Experienced Judgment

It is probable that little real progress has been made in this field over the years because of the complexity of the problems involved in arriving at a scientific answer indicating return on investment achievable for a proposed facility. Seat-of-the-pants judgment, carefully exercised by experienced capable businessmen, has resulted in wise investments that earned good returns and consequent success and growth of their companies. Seat-of-the-pants judgment carelessly applied by inexperienced men has resulted in many business failures.

Over the long haul the manner in which capital dollars are invested will determine a manufacturing company's competitive position in the market, at least as much as any other facet in the operation of the business. Because of this fact, final de-

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

Real dollar payoff with more automated installations can be extremely elusive. To be sure of financial success, no one simple formula is suitable. Evolution of processing equipment to maintain profits must include consideration of all facets—simple improvements, product design changes, entire production line replacements at once or over a period of time.

cision on whether and when capital investments are to be made must be the responsibility of the top executive or operations committee of the enterprise. These men cannot do the analysis of all investment proposals themselves, therefore they must of necessity depend upon the accuracy and completeness of data prepared for them by subordinates down the line.

Training of the analysts in the several divisions of a corporation in the consistent application of an analysis procedure is of prime importance. Training is also of prime importance to the executives who must make the final decisions for approval or rejection of capital expenditure proposals. They need training in the uniform understanding of the value to the corporation and to themselves as individuals of use of the analysis procedure as an aid to the application of sound business judgment in evaluating investment proposals.

In a multidivision corporation, a corporate staff group such as a manufacturing services department should have extensive manufacturing knowledge in the areas in which the various divisions are involved, and of their facilities and needs. Such a staff group is then in the ideal position to train the division analysts, to review their recommendations, and to audit the performance results obtained after installation and use of new facilities. In a smaller company, the manufacturing manager or manufacturing engineer should train the analysts or do the analysis of manufacturing facility investment proposals.

As of today there is no known formula that will crank out guaranteed answers to sound, profitable manufacturing facility investment proposals. At best, the available formulas and procedures can be considered as more or less formalized standard techniques to *aid experienced business judgment* in evaluating: 1. The merits of a proposed investment. 2. The relative merits of various proposals to accomplish a given function. 3. The relative merits of various proposals competing for allocation of available funds. Good, sound, experienced business judgment is still the prime factor in the making of profitable facility investments, just as it was many years ago before the concept of return on investment as a measure of performance had been developed.

Now, we have laid the groundwork of the measure of worth of a manufacturing investment, the broad financial objectives being sought, the complexities facing the analyst of the various proposals, the magnitude of the importance of making sound capital investments, and the prime importance of sound experienced business judgment in the making of correct decisions in this area. The remainder of this paper will deal with the development of costs and savings allied with a proposed facility investment, and the conversion of this data into a recommendation for favorable action based upon return on investment and other useful indexes of worth of the proposal.

▶ Use Standardized Procedures

Formalized, standard techniques should be used in the analysis of all capital expenditure proposals covering individual items of equipment, or complete programs involving facilities. It is suggested that the procedure should be used where: 1. The total capital expenditure involved is $5000 or over. 2. The proposal is based upon cost reduction.

Such a procedure should not be used where a proposal is based solely upon intangible considerations. This type of proposal should be kept to a minimum.

When a program would involve facilities for a complete new product line, where no facilities currently are available, the procedure should be used for evaluating the relative merits of various proposals to accomplish each given function. Evaluations should be made by comparing the savings accomplished by each more costly proposal to the net additional capital investment required by that proposal

over the least costly proposal. For the program as a whole, the return on investment should be developed by preparing annual operating statements normally covering a 15 to 20-year projection of operations.

Each facility investment proposal should be considered in the light of existing conditions and be evaluated on the basis of the net capital investment involved, the net capital investment being the increase in book value of assets resulting from the proposal. Thus, a proposal involving a capital acquisition cost of $100,000 for new equipment and releasing for sale existing equipment which has an undepreciated balance (depreciated book value) of $5000, requires a net capital investment of $95,000. If no existing facilities are to be sold as a result of the new capital acquisition of $100,000, the net capital investment to be evaluated is $100,000, even though existing facilities are made available for other work.

Prime Measure of Worth

Return on net capital investment, before Federal income tax, should be the prime measure of value

Capital Expenditure Analysis
Proposal Data and Results Expected — Work Sheet I

1. Application Description: Drill & Tap Main & Interpoles
Analysis No.
Date: 10-22-59
By: JJK-KHM
Location: Ivanhoe Div.

2. Present Equipment Data:
a) Description: 3-Spindle gang drill
b) Present Book Value (Per Acctg. Books) $ -0-
c) Present Market Value $ 200
d) Capital Gain (c-b) $
e) " Loss (c-b) $
f) Current Rebuild or Retool Cost $
g) Age of equipment 14 Yrs.

3. Proposed Equipment Data:
a) Description: Automatic Drill & Tap Machine
b) Acquisition Cost (Capital) $57,507
c) " " (Expense) $ 2,000
d) Install. & Trans. Cost $ 2,885
e) Removal Cost-Pres. Equip. $ -
f) Total Acq.Exp.(c+d+e) $ 4,885
g) Service Life 15 yrs.

Notes: Present Machine worn out - must be replaced. $4,594 included in capital is tooling.

4.a) Net Capital Investment (3b - 2b) $57,507
b) Net Cash Expenditure-after tax(3b+.48x3f+.25x3d-2c-2e) $29,335

5. Results Expected:
a) Return on Net Capital Investment - Average - before tax 42.9 %
b) " " " " " after tax 20.5 %
c) Pay-back - before depreciation - before tax 4.6 Yrs.
d) Investor's rate method-after tax-interest rate on Net Cash Expend. 11.0 %
e) Inventory change (decrease or increase - Cross Out One) $27,000

Notes: Total potential inventory reduction for complete pole line is $44,500 @ $27.0 million operating rate. 60% of reduction is credited to this machine & is expected to be accomplished. Remainder depends upon improved assembly method.
Depreciation equivalent of alternate (of replacement with machines of same type as present) is taken as a 'cost saving' for proposed machine.

6. Important Intangible Considerations:
Upon completion of line for pole making, factory order paper can be eliminated, and poles be produced in lot sizes of 3 sets or one days usage, whichever is greater.

Form 1903A2

AN EXAMPLE SHOWING FORMS AND CALCULATIONS

Drilling, tapping, and counterboring of the frame mounting holes in the main poles and interpoles of integral horsepower direct current industrial electric motors was currently being performed in a three spindle gang drill using guide ways and individual cap type drill jigs for locating the

Capital Expenditure Analysis
SAVINGS AND COST DATA - BEFORE TAX — WORK SHEET II

Operate Savings Net:
1st Yr = Oper. Sav. Gross - Total Acq. Exp. (3f) - Depr. Net
Rest = Oper. Sav. Gross - Depr. Net

Net Capital Investment (4a) $ 57,507

Year	Assignable Labor	Assignable Mat'l.	Rebuild or Retool	Other Assignable Savings or (Costs): Drill Jigs Maint.	Vise Maint.	Inventory	Depreciation of replaced	Depreciation 2nd replace.	Install of replacem.	Operate Savings Gross	Depreciation Net	Book Value Net	Operate Savings Net
1	5,440		4,750	900		3,470	1,040		500	16,100	11,460	46,050	4,640
2	6,040					2,860	900	1,040	500	13,240	5,970	40,080	7,270
3	3,930					2,510	780	900		9,020	5,190	34,890	2,830
4	5,440					3,470	670	780		11,280	4,560	30,330	6,720
5	6,550					4,190	600	670		12,730	3,970	26,360	8,960
6	5,750		4,750			3,470	510	600		16,180	3,380	22,980	12,800
7			300				460	510		11,750	3,010	19,970	8,770
8					(500)		390	460		10,970	2,590	17,390	8,380
9							340	390		11,360	2,220	15,170	9,130
10			300				300	340		11,260	2,010	12,960	9,250
11			4,750				260	300		15,630	1,690	11,470	13,940
12			300				220	260		11,100	1,480	9,990	9,620
13							190	220		11,030	1,270	8,720	9,760
14							180	190		10,990	1,160	7,560	9,830
15	5,750		300	900		3,470	140	180		10,940	960	6,600	9,990
16													
17													
18													
19													
20													
Total										(1a) 183,760		314,770	(3a) 132,860
Aver.												(1b) 20,780	(3b) 8,860

Results Expected: 5a. Return on Net Capital Investment - after depreciation - before tax (11b ÷ 11c) = 42.8 %
5b. Return on Net Capital Investment - after depreciation - after tax (.48 x 5a) = 20.5 %

Note: If capital gain or loss is appreciable, add 75% of gain or subtract 100% of loss to Operate Savings after tax (.48 x 11a), then average and ÷ by 11c.

5c. Pay-back - before depreciation - before tax - (add Operate Savings to equal Net Cap. Invest. (4a) = 4.6 Yr.

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to be considered by the operations executives when making decisions on capital expenditure proposals. This return is the percentage relationship between the average net operating savings before taxes, but after depreciation charges, and the average book value of the net capital investment, both averages being taken over the service life of the proposed asset.

Net operating savings are gross operating savings less the difference between the depreciation charges being assessed against the existing facilities, and the depreciation charges that would be assessed against the new facilities. Gross operating savings are the difference between all savings and costs incurred as a result of the proposed investment, when compared to the costs of manufacture with the existing facilities.

Depreciation charges are generally determined by a controller's department, based upon many factors often beyond the knowledge of the capital expenditure analyst. However, it is important that the controller's department have knowledge of the service life of the facilities being proposed. Only with this knowledge can the controller's department select the most appropriate depreciation schedule.

Service life is the estimated time, in years, that the proposed facilities could be expected to be usable at the production volume planned, even though technological improvements could obsolete the equipment before it becomes worn out. In estimating service life, the following factors should be considered: 1. Number of shifts per day the equipment would be operated. 2. Severity of operating conditions (load, shock, vibration, heat, abrasives involved, corrosives present, building or mounting, conditions, etc.). 3. Equipment construction features to protect against severe operating conditions. 4. Skill of operators, setup personnel, and maintenance personnel. 5. Effect of turnover of operators and setup personnel. 6. Effect of incentives on equipment care, abuse, and maintenance.

If the product line for which the facilities are being proposed has a life shorter than the facilities, and will not likely be replaced by a product line that could effectively use the facilities, the service life should be shortened to equal the life of the product line, and salvage value of the facilities should be estimated and used as a saving in the terminal year. If *known* improved equipment, or revised methods will be available in the near future, the service life for the facilities being considered

holes. The operation was quite efficient for a manually loaded, manually indexed, and manually unloaded cycle.

As the equipment approached the end of its service life, automated means were considered in the light of existing lot quantities and forecasted total quantities. The investigation developed a special machine with improved clamping and locating means and with combination automatic and operator-controlled index and machining cycles. Considerably improved setup time requirements permit reducing inventory materially without adversely affecting machining costs. Manual loading and unloading during the machining cycle is retained.

In checking the degree of automation it was found that zero return on investment would result from replacing the worn out machine with a modern machine of the same type, since the existing setup and operating time standards would not be significantly improved. The only savings with new equipment would be in reduced maintenance and downtime. These savings would be more than offset by the added depreciation charges.

Addition of automatic loading and unloading has not been studied because the preceding operation has not yet been re-studied. Judgment indicates that automation of that operation will not likely result in economical elimination of manual unloading of that operation and loading of the drilling operation.

Sample forms illustrate data developed to evaluate a proposal for the drilling, tapping, and counterboring operations. Work Sheet I summarizes the proposal data and results expected. Work Sheet II records the savings and cost data and the calculation of the indexes of worth. Work Sheet III records the Investor's Rate Method data and selection of the interest rate.

The net cash returns are multiplied by factors from a standard-interest factor table to get the present value of all cash returns during the service life of the proposed equipment. The interest rate at which the total of the present values of cash returns for the service life equals the net cash expenditure is the interest rate for the Investor's Rate Method.

The return on investment of 42.8 per cent before tax is considered very good, particularly when an inventory reduction of almost half of the cost of the equipment can be accomplished, and when the machining method being replaced was a fairly modern, efficient method.

Capital Expenditure Analysis — Work Sheet III

Investor's Rate Method - Data and Calculation - After Tax

Net Cash Expenditures (4b) $ 59,335

Net Capital Investment for Depreciation Tax Credit (4c) $ 57,507

Year	Operate Savings .48x11d	Deprec. Tax Credit	Net Cash Return	Int. 10% Present Value Factor	Present Value of Cash Return	Int. 11% Present Value Factor	Present Value of Cash Return	Int. __% Present Value Factor
1	7,730	5,490	13,530	.909	12,300	.901	12,190	
2	6,360	2,150	9,480	.826	7,830	.812	7,700	
3	4,330	2,700	7,030	.751	5,280	.731	5,140	
4	5,470	2,530	7,740	.683	5,290	.659	5,100	
5	6,210	2,060	8,270	.621	5,140	.593	4,910	
6	7,770	1,800	9,570	.565	5,400	.535	5,120	
7	5,630	1,530	7,160	.513	3,680	.482	3,450	
8	5,270	1,320	6,590	.467	3,070	.434	2,860	
9	5,450	1,160	6,610	.424	2,800	.391	2,580	
10	5,480	1,010	6,490	.386	2,470	.352	2,260	
11	7,620	900	8,520	.350	2,940	.317	2,660	
12	5,330	790	6,120	.319	1,950	.286	1,750	
13	5,290	690	5,980	.290	1,730	.258	1,540	
14	5,280	580	5,860	.263	1,540	.232	1,360	
15	5,260	530	5,790	.239	1,380	.209	1,210	
16								
17								
18								
19								
20								
Total					67,800		59,330	

Results Expected:

5% - Investor's Rate Method - after tax - Interest Rate 11.0 %

Form 1903C2

should be appropriately shortened, and salvage value estimated and used as a saving in the terminal year.

Secondary Measures of Worth

Return on net capital investment, after Federal income tax, is a secondary index of the worth of a proposed investment. With the current 52 per cent tax rate, except for proposals involving appreciable capital gain or loss on facilities that will be sold as a result of the proposal, the return will be 48 per cent of the return on net capital investment before tax. If a capital gain would be appreciable, 75 per cent of the gain should be added to the net operating savings total for the service life of the facilities, then 48 per cent of that total used to compute the return on investment. (25 per cent of the capital gain is Federal tax.) If a capital loss would be appreciable, 100 per cent of the loss should be deducted from the net operating savings total for the service life of the facilities, then 48 per cent of that total used to compute the return on investment. (Capital losses can generally be deducted as business expenses before Federal tax.)

Payback is another index of worth of an investment. It is one of the oldest measures used, and probably one of the least valuable. As years go by, in the opinion of this writer, it will probably be completely dropped from use by executives in the manufacturing and processing industries.

Payback may be calculated either before or after depreciation, and before or after Federal income tax. Simplest, and most normally used, is the before depreciation, before tax basis. This gives an indication of how many years would be required to get the money required by the investment back into working capital. It is a measure of risk, but of itself gives no indication of the profitability of the proposal. It can be used to compare relative risks between two or more proposals, but cannot indicate which proposal would be better over its life.

Investor's Rate Method

The Investor's Rate Method is another index of the worth of an investment that is gaining in use. The Investor's Rate Method expresses a return on the total net cash expenditure, after tax, required by the proposal, in the form of an annually compounded interest rate. Calculation of this interest rate is a fairly complicated and time-consuming process. In theory, a proposed investment that would show an interest rate in excess of the interest rate that would have to be paid out to borrow money for the investment, would be a profitable investment. This is because the Investor's Rate Method discounts future savings to a present value, and therefore fully takes into account the time-shape of the operating savings after tax.

As a practical matter, however, it is necessary to add reasonable safety factors to offset errors in the analysis data that exist in the various areas of forecasts, proposals, quotations, estimates, and guesstimates involved. Until such time as more background is available in the use of this index, an interest rate bogey for the Investor's Rate Method of the order of 9 per cent is suggested for production machinery proposed for cost reduction.

In my own company we only use the Investor's Rate Method under the following conditions: 1. When return on net capital investment is in the 30 to 50 per cent range, the total acquisition expense is an appreciable proportion (15 per cent or more) of the net capital investment, and the operating savings net in the first three to five years are low in relation to savings in the latter years. 2. When leasing is an alternative in financing an investment being considered.

Evaluation Policies

In describing the various measures of investment worth no distinction has been indicated between facility proposals covering automated, or nonautomated equipment. No distinction should exist in the measures, or in the methods of reporting. Likewise, no distinction should exist in the compilation of data, calculation of returns, or in the policies controlling the derivation of costs and savings.

More careful consideration of many items is deserved, whenever expensive automated equipment is being considered, than is necessary when simple standard equipment is being considered. Such items include engineering costs, installation costs, debugging costs, setup costs, labor savings (both direct and indirect), material savings, maintenance costs, scrap and salvage savings, inspection savings, flexibility costs (rebuilding that might be required by product line changes), floor space requirements, terminal values in cases where facilities may not be worn out at time of disposal, quality improvement, manufacturing cycle reduction, inventory savings, etc.

Intangible considerations must never be ignored, but whenever practicable should be converted to dollars. For example, quality improvement that reduces scrap should be evaluated in dollars, while quality improvement that is purported to increase sales should not be evaluated. Decreased delivery cycles that reduce production planning, dispatching, or inventory should be evaluated, while reduced delivery cycles that may increase sales should not be evaluated. Improved safety should not be evaluated.

One psychological reason for not trying to convert all intangibles into dollar evaluations is that opening of the door to "thumb sucked" dollar evaluations in the intangible areas may invite "thumb sucked" dollar evaluations in other areas of an analysis where digging and study would otherwise produce factual dollar values.

Important policies in the derivation of various items of costs and savings are:

1. Labor. Labor should be evaluated at straight time average earnings, plus fringe benefit cost, of the

specific personnel involved when actual hours worked are used. Job rates, plus fringe benefit cost, of the specific personnel involved should be used when standard hours are used.

Overtime and shift bonuses should only be evaluated if directly affected by the proposal, and only to the extent affected, e.g., first year projected operating volume might require 2-shift operation plus 5 hours per shift overtime on existing equipment, and 1½-shift operation without overtime for the proposed equipment. For the first year, shift bonus saving for ½ shift, plus overtime bonus of 10 hours per week should be credited to the proposed equipment. Second year projected volume might require 3-shift operation without overtime for the existing equipment, and 2-shift operation without overtime for the proposed equipment. For the second year, shift bonus saving should be credited to the proposed equipment.

Indirect labor that may be specifically identified as a greater or lesser requirement of the proposal as compared to the existing requirement may be evaluated as under the first and second points. Indirect labor as a percentage of direct labor, or as an average of a plant or department, should not be used.

2. Material. Material should be evaluated at actual cost, not at standard cost.

3. Overhead. Overheads in terms of percentages of direct labor, or averages of plant or department, or fixed rates made up of variable expenses for a plant or department, should not be used. Only specifically identifiable items that would be affected by the proposal should be evaluated. Some of these items are: Power, perishable tools, supplies, supervision, and clerical.

4. Rebuilding. Rebuilding of existing equipment should be considered as deferred maintenance, and charged as a cost in the year in which the work is to be performed, when such rebuilding is restoration from wear and tear rather than from basic design change.

Rebuilding of equipment for basic design change, whether for existing or proposed equipment, is a capital expenditure. The additional capital investment for the rebuilding should be included in the analysis in the year in which the work is to be performed. This should be done to properly reflect an increase or decrease in the net capital investment (thus in the depreciation charges) and in the calculated return on investment.

Expenses incident to a capital rebuilding job should be included as costs in the year incurred. Such expenses as disconnecting, moving, cleaning, painting, reconnecting, operator time losses and extra costs involved in subcontracts to maintain production fall into this class.

Proper handling of rebuilding costs is particularly important with automated equipment. Product line changes are most likely to be the reason for capital rebuilding of automated equipment. It is unrealistic to "sluff off" rebuilding costs as a necessity of the product line change and thus throw the cost against the redesign, while still showing a high return on investment on the automated equipment as originally proposed. Whenever product line change can be predicted during the service life of the proposed equipment, rebuilding costs should be estimated and be included in the analysis of return on investment on the proposed equipment. The net result of this method of handling might well be the selection of different equipment that would have a greater true return over its service life than equipment considered without regard to product line changes.

5. Retooling. Retooling incident to wear is generally expense and should be included as a cost in the year incurred.

Retooling incident to product line redesign is normally chargeable as a cost of the redesign, but should be considered directly in the analysis of return on investment of the proposed equipment, for the same reasons cited with regard to rebuilding costs.

6. Floor Space. Costs of floor space can generally be ignored because differentials are not often significant. If sufficient areas are released to permit assured productive use of the area, or if less space would be required in a new building that is part of the proposal, then credit should be allocated to the proposal by way of reducing the net capital investment by the depreciated book value of existing space released, or the cost of new space saved. If extra space is required by the proposal, the net capital investment should be increased accordingly.

7. Debugging. Setup, operator and service labor, maintenance manpower, material scrapped, part salvage, supervision, manufacturing engineering, perishable tool breakage, inspection, utilities, subcontract production, and retooling are some of the items that make up debugging costs.

General tendency is to be over-optimistic in estimating the costs of debugging equipment. Part of this tendency is due to inexperience and lack of accurate accumulation of all of the costs incurred. The remainder is an unwillingness to face up in advance to the potential costs known to be involved. An honest desire to recommend purchase of only those facilities that will show a true return on investment up to the established bogies, assisted by a post-operative audit of actual results vs proposal results, can overcome the very human desires of manufacturing men to have the very latest, most highly automated "gismos" available.

Clearly defined specifications of quality and performance included in the purchase agreement, with demonstration of results in the facilities manufacturer's plant before shipment or payment, will materially assist in minimizing debugging costs.

8. Engineering. Manufacturing engineering costs involved in the studies leading up to purchase of new equipment must not be ignored, but should not be charged as a cost in the analysis of return on investment.

Methods refinement, time study, standards establishment, incentive plan development, etc., involved after debugging may or may not be charged as a cost in the analysis of return on investment. This is a policy matter, but generally it is understood that these costs are not included in the analysis.

9. Maintenance. This is another area in which lack of information and over-optimism are quite often present. Training costs incurred in the upgrading of maintenance personnel in the intricacies of electronic, magnetic, and hydraulic components and their circuits should be considered as a normal cost of business, not something to be levied against any single piece of equipment. The labor, renewal parts (both used and inventoried), and supplies involved with the proposal should be analyzed carefully, and be included in the return calculation. Discussion with equipment manufacturers and users of similar equipment can provide reliable information to supplement the buyer's own experience.

10. Inventory. Costs of carrying inventory vary materially from one business to another, and are very elusive at best. Savings or extra costs involved in a proposal for new facilities should be conservatively estimated. Only specific inventory cost items affected by the proposal should be evaluated. These costs should be developed as a percentage of the dollar value of the inventory change resulting from the proposal.

One or more of the following items may be affected by the proposal: 1. Cost of money (Use the lower of the existing corporate capital distribution, or borrowing cost). 2. Obsolescence (Consider the particular product line involved). 3. Material handling (Estimate costs of handling into and out of the warehouse). 4. Clerical and inventory taking. 5. Taxes. 6. Insurance.

11. Inflation. No inflation or deflation should be considered. All figures used should be in current dollars. Caution is required to avoid inclusion of inflation that could be included in sales forecasts.

12. Salvage Value. Salvage value of the proposed equipment is not normally a factor in the analysis, since the proposed equipment is normally expected to be used for its full service life. Its actual value becomes a factor in the "next generation" proposal.

As previously noted, if known improved equipment or revised methods will be available in the near future, and the service life has been appropriately shortened, then the salvage value of the proposed equipment may be appreciable and should be estimated and included as a saving in the terminal year.

13. Sales Forecast. Although recorded last in this listing of important policies in the analysis, the sales forecast is the single most important factor in the evaluation of all capital investment proposals. Use of a 5-year forecast, by years, is recommended as the basis for all capital investment analyses. In general, this 5-year forecast is the basis for all corporate planning, and therefore deserves development by specialists in market analysis, combined with study and adjustment by top operations executives.

The sales forecast will most likely be in total dollars, with some breakdown into product lines, but probably not into specific frame sizes or part numbers. The production planning department should convert the sales forecast into the frame size and part number breakdown, making sure with the engineering department that planned product line redesigns are taken into account. Savings and costs, then, are developed on the volume figures from this breakdown of the sales forecast, by years, for the first five years of the analysis.

For the remaining years of the service life of the proposed facilities the highest "normal" yearly operating rate during the first 5-year period should be used, unless other known factors (e.g., obsoleting of a line of product) would indicate some lower forecast for the remaining years. Selection of the "normal" rather than the highest yearly rate or the fifth-year rate is suggested to eliminate cyclical changes. It is unwise to follow a trend line for more than five years into the future, and gamble capital investment on such nebulous future expansion. The crystal ball used by all forecasters is cloudy enough when seeking answers for the next quarter, and is hardly even transluscent when looking five years ahead. Beyond that it is about as clear as the proverbial 8-ball when considered in the light of requirements for a particular proposed facility.

Payoff in Greater Profits

Simple forms suffice for recording the pertinent data for any facilities proposal. These forms assist in calculating the various indexes of worth of the proposal and summarize them so that operations executives can readily assimilate the important factors in the proposal. Back-up data should be available to anyone wishing to dig more deeply into the details of costs, savings, etc.

Use of the policies and measures of worth suggested, combined with accurately developed costs and savings applied to the operating levels predicted in a good sales forecast, should result in the making of wise, profitable investments. Profit potentials will be maximized, however, only if capital investment proposals for automated equipment contemplate the right degree of automation. Too much automation can reduce the potential return on investment, just as surely as too little automation.

Sound business judgment may be warped by the intrigue of automation. Be sure to confirm any judgment on a major expenditure for automated equipment by analyzing not only the return on investment to be obtained on the equipment proposal believed to be desirable, but also on equipment that is more highly automated, and on equipment that is less highly automated. In some instances a better investment than first thought possible can be realized by either spending more for more highly automated facilities, or by spending less for less highly automated facilities.

In any case, getting a grip on the real costs and savings involved in various proposals will pay off in greater returns on the investments involved, and therefore in greater profits to the enterprise.

MAGNET EQUIPPED CARRIERS INCREASE PROCESS FLEXIBILITY

AN IMPORTANT aspect of handling is the selection of carriers to hold parts and components as they are moved through processing equipment. When only one type of part is to be processed, it is a simple matter to procure a carrier of standard design or to design and build a special carrier for the part. However, when many different types of parts must be processed through the same equipment, carrier types can multiply and procurement can become a sizable cost item for the project. In such cases, standard carriers equipped with permanent magnets to position and hold the parts can effectively handle a great number of ferrous parts having different sizes and shapes.

For example, at the Dodge Div., Chrysler Corp., magnet equipped carriers are used to transport approximately 150 different automobile trim parts through a spray painting and baking oven line. These parts vary in size and shape and include small interior trim parts, window moldings, and large parts such as folding seat backs. The versatility of the carriers makes it possible to handle all the parts on only a few different types of carriers.

These particular carriers were built by Eriez Mfg. Co. and consist of double-ended, tube-type magnets mounted on steel frames, *Fig.* 1. The attracting and holding powers of the magnets permit fast and easy loading of parts since operators do not have to position the parts in clamps or over hooks or pins. A major advantage of the carriers is that parts do not require holes, flanges, or lips as a means for supporting the work. If the magnets can attract and hold a part at two or more points, the part cannot drop off the carrier and can be subjected to blowing off operations, pressure of spray painting, and wiping or paint touchup.

At the Dodge plant, the carriers are hung from hooks on a monorail conveyor and conveyed to a tack off operation where parts are wiped clean. The parts are then moved through a paint spray booth and into an infrared baking oven. Although the temperature in the oven is approximately 275 F, the holding power of the magnets is not affected since the magnetic strength of the carriers is stable up to 750 F. From baking and drying, the finished parts are conveyed to an unloading area, *Fig.* 2, where operators quickly "snap" the parts from the carriers.

Carriers equipped with permanent magnets can be used with a variety of industrial processes. In addition to painting and baking operations, the carriers have been used to convey parts through washing machines, dip tanks, coating machines, and plating equipment. When part sizes and shapes change due to model changes, no changes are necessary in the magnet equipped carriers. The same carriers can be used year in and year out for handling new shapes and sizes.

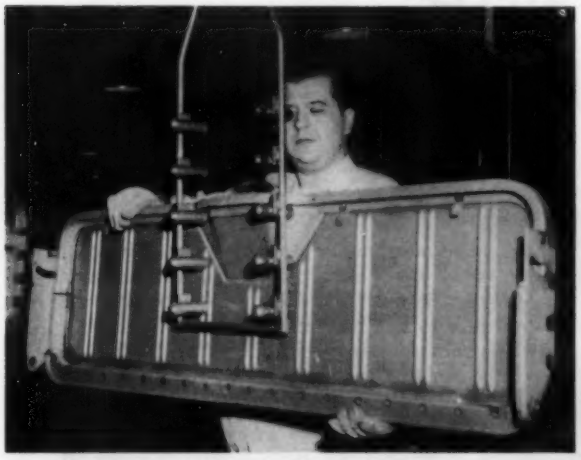
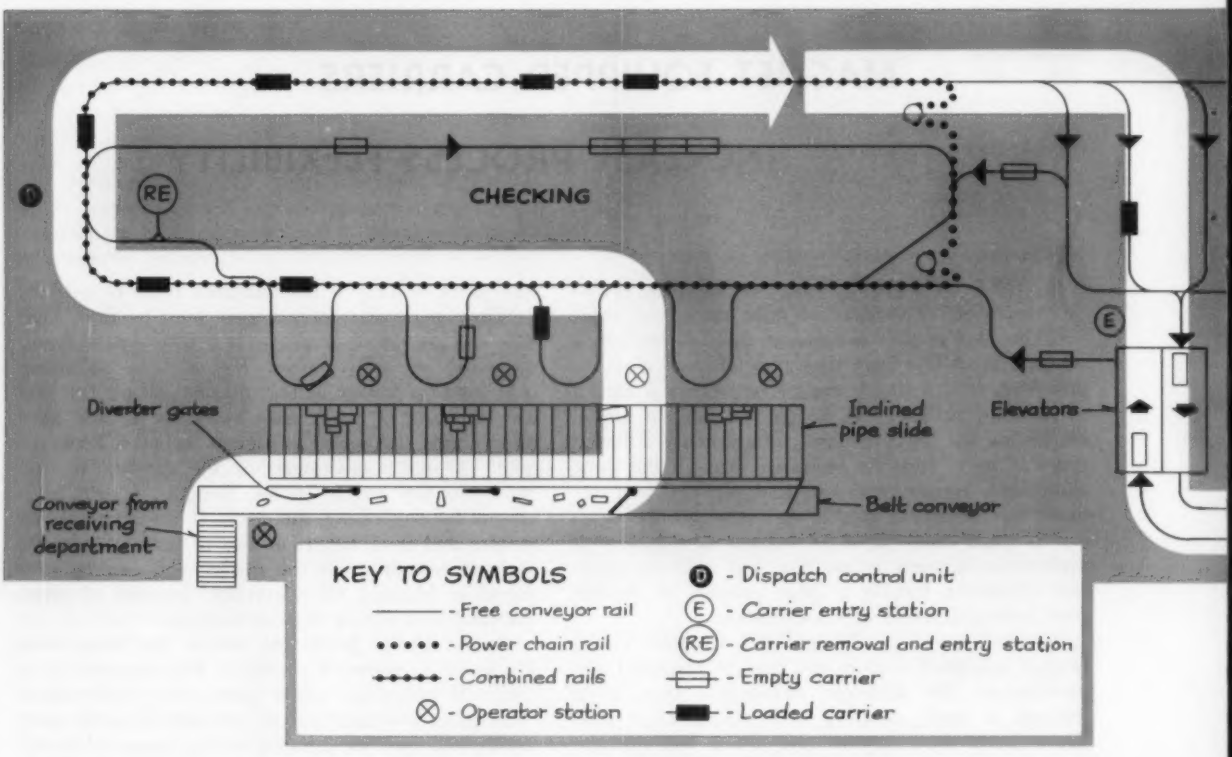


Fig. 1—Large folding seat back for Dodge automobiles is quickly loaded onto moving carrier equipped with ten double-ended magnets. Part is held securely for trip through tack off, spray painting, and baking operations.

Fig. 2—At the unloading point of the processing line, operators are twisting or "snapping" parts off carriers having twelve magnets. In the right background is another type carrier having six magnets which conveys four window moldings.



AUTOMATION TODAY

HANDLING RETAIL MERCHANDISE

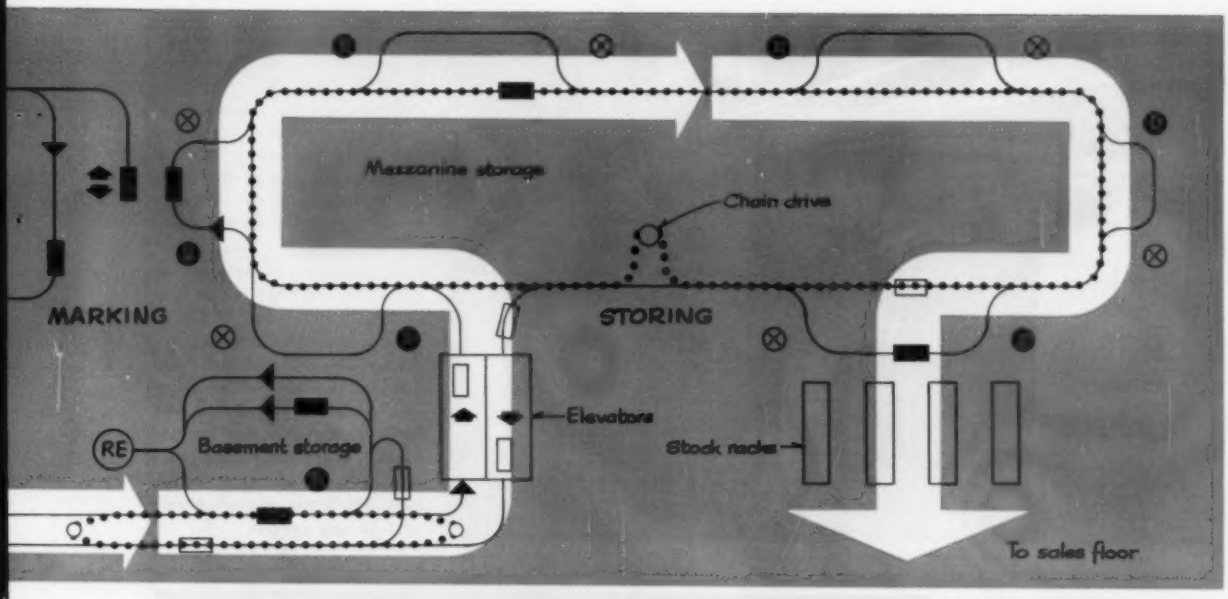
CONTINUAL NECESSITY in retail department store operations is that of efficiently transferring a variety of goods, arriving in random sequence, within and between receiving, checking, marking, and pre-sales storage areas. At the downtown St. Louis department store of Famous-Barr Co., this problem was compounded by an awkward physical layout of buildings.

With the existing layout, incoming merchandise is received in a service building located across a street from the retail store. After it is checked and price-marked on another service building level, the goods must be sent to the retail store through a narrow tunnel extending under the street. In the store, the merchandise is taken either to basement or mezzanine storage areas.

This procedure often created handling difficulties, especially during peak seasons, and resulted in the installation of a mechanical handling system that includes a combination of free and powered monorails to move merchandise on carriers. A feature of the system is use of electronic dispatching controls whereby carriers may be diverted automatically from powered rails to free rail sections at preset locations.

As merchandise is received at the loading dock of the service building it is placed on a flat roller conveyor which can be fed from any point on the dock. It is then carried to the second floor of the building by means of an inclined pusher bar conveyor. As the packages ascend to the second floor, they are tagged by a receiving clerk with a receiving record. The boxes then move on a conveyor belt until a dispatcher flips a switch which swings a deflecting bar across the belt, diverting the packages at the proper points so that they slide down a pipe incline to the correct checking points.

At each checking point an operator opens the cartons, checks their contents, and loads them into a carrier suspended from a free monorail loop at his checking station. Carriers are shunted to the free



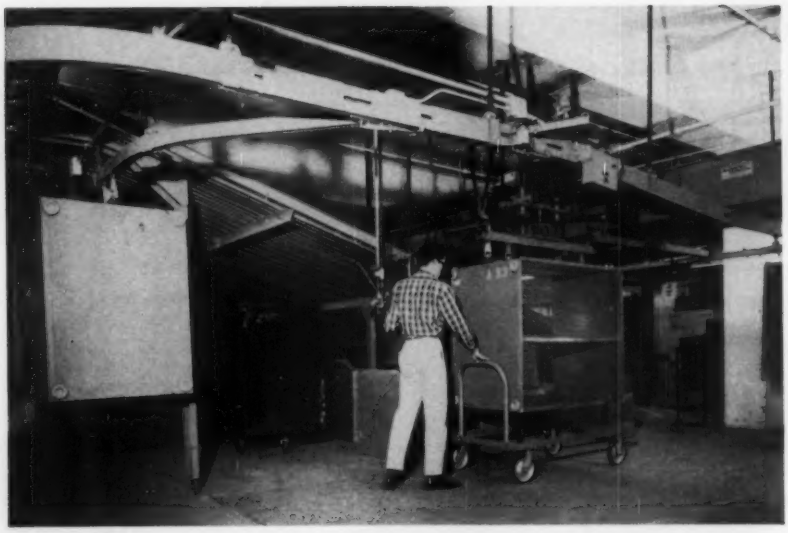
1 Simplified diagram illustrates major elements of handling system used to transport merchandise on carriers through receiving, marking, and storage sections of a department store. Carriers can be programmed so that they are switched automatically from powered conveyor rails to free rail sections at various locations. System also includes provision for returning empty carriers to receiving area.

loops from a powered rail by operation of a manual wedge switch. When a carrier has been loaded with up to 300 pounds of merchandise, the checker sets a dial on the carrier designating its ultimate stockroom destination, and pushes the carrier along the free loop and back onto the powered rail.

Carriers that have been returned to the power rail are moved at a rate of 30 fpm to a price-marking area where they are shunted, according to demand, onto multiple free spur lines. When a carrier has been stopped on a line, an operator attaches a price tag to each item in the load. A supervisor next checks the dial setting on the carrier and shunts the carrier onto a monorail line leading to an elevator in the service building above the tunnel.

Elevators are located in pairs at each end of the tunnel. Each unit is designed to move carriers in one vertical direction only. The carriers roll onto a

2 Incoming merchandise is brought up from receiving dock of service building on inclined conveyor, foreground, and discharged to a belt conveyor running along rear of pipe slide. A dispatcher has examined the packages and directed them to the proper portions of the pipe slide by means of diverter gates above the belt conveyor. Checkers at free rail conveyor loops, shown, open the packages, check quantities against purchase orders, and place acceptable goods on carriers. When a carrier is loaded, checker sets a dial on the carrier to designate ultimate stockroom destination, and pushes the carrier from the free rail loop onto a common power rail for transport to price-marking area. Trash resulting from checking operation is taken away on conveyor belt above pipe slide.



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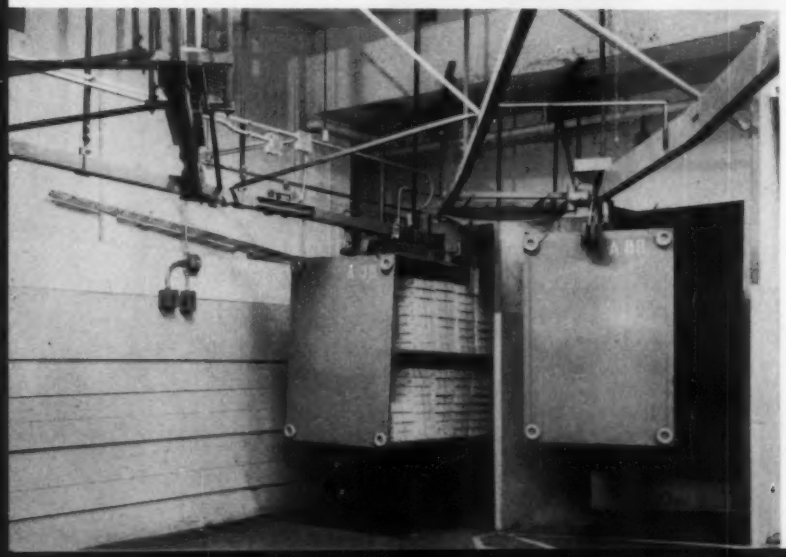
Carriers may be taken off or charged into the conveyor system at several points by means of pneumatic drop and lift stations in free rail sections. Enclosure on main rail (in foreground above hand truck) houses a dispatching or decoding unit that senses dial settings on carriers. If a dial setting calls for routing an empty carrier from the main line to storage under pipe rail, wedge switch above and behind operator will be actuated electrically and carrier will be diverted automatically from powered rail to free rail section.

4

Loaded carriers that have been moved from the receiving area to the marking area on a powered rail are transferred to the system of free rail sections shown. An operator at each free rail section obtains carriers from a feeder line by operating a manual stub switch. The operator attaches retail price tags to the merchandise while it remains on the carrier, then summons an area supervisor. The supervisor checks the dial setting on the carrier and pushes the carrier onto an exit line where the carrier is moved to an elevator leading to the basement of the service building.



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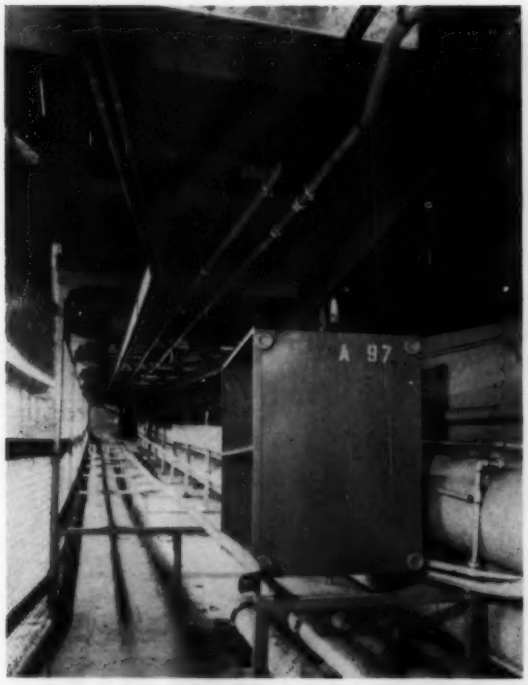
View of upper entrance to elevator shaft in service building shows loaded carrier, left, entering *Down* lift as empty carrier, right, emerges from *Up* lift. Spur line projecting from free rail at upper left includes a pneumatic drop and lift station where carriers may be charged into the system. Free rail includes a weighing station where loaded carriers are checked for weight before entering *Down* lift.



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Carriers that have been lowered to basement level by elevators pass between the service building and the retail store through this tunnel. Powered monorails were installed beneath existing belt conveyors that are still in use, principally for transporting packages wrapped for customers. Tunnel is 140 feet long and passes beneath a public street.

short piece of track in each lift and trip a switch activating the lift. If a lift is busy, switches stop the carriers until the lift returns.

At basement level carriers cross the tunnel on powered rails and proceed to the store. Several safety devices are provided at the crossing point to eliminate traffic accidents. These include a *Stop-Go* light and a warning signal activated by a photoelectric cell. In operation of the warning signal, momentary obstructions are disregarded. However, if an obstruction remains, power to the rails is shut off. Carriers then cannot be taken across the tunnel until the obstacle is removed and a *Start* pushbutton is depressed.

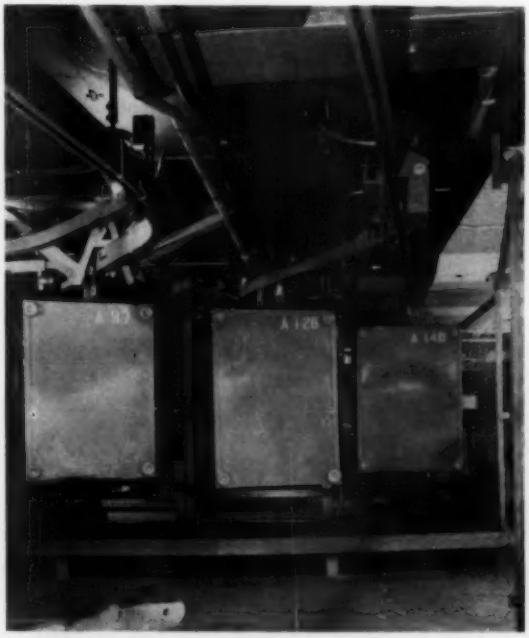
At the store end of the tunnel, carriers are diverted by means of transistorized dispatching or decoding stations. Each decoding station employs plug-in contact brushes that can be arranged in various patterns on plugboards. As a carrier passes a station, the setting of the dial on the carrier is sensed by the contact brushes. If the setting corresponds to the positions of the brushes on the decoding station, an electrically operated conveyor switch will be actuated.

Thus, as it arrives at the store, a carrier may be routed either to the basement stock area which supplies basement sales departments or onto an automatic lift that takes the carrier to the mezzanine.

Carriers that are elevated to the mezzanine level are automatically directed to the correct one of several stock areas served by free monorail loops. The free loops are grouped around a central powered rail line. If a loop is completely filled with carriers, the decoding station controlling the track switch for that loop will recirculate the carrier until it can be received by the loop. Carriers admitted to the proper free rail loops are unloaded and the stock placed on shelves. The unloaded carriers are then pushed back onto the powered rail by hand for return to the receiving building.

Stock areas are located as nearly as possible above the departments they serve. To speed the delivery of merchandise to the selling floor, four shelf truck lifts have been spaced around the balcony and convey merchandise to the first floor.

The project, whereby merchandise is moved smoothly and efficiently between departments on from 30 to 40 carriers per hour, represents the co-



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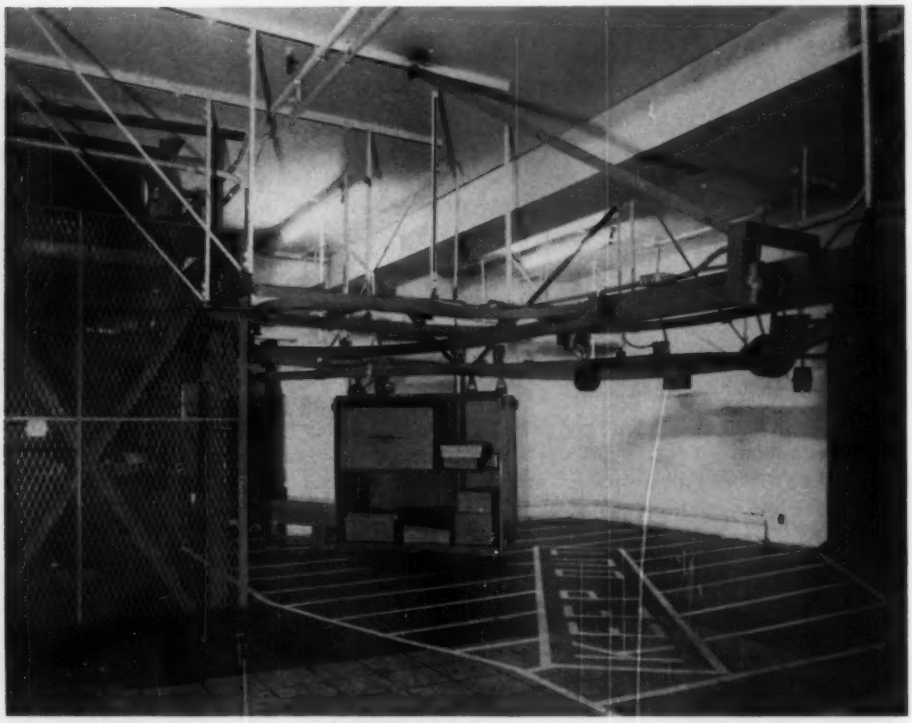
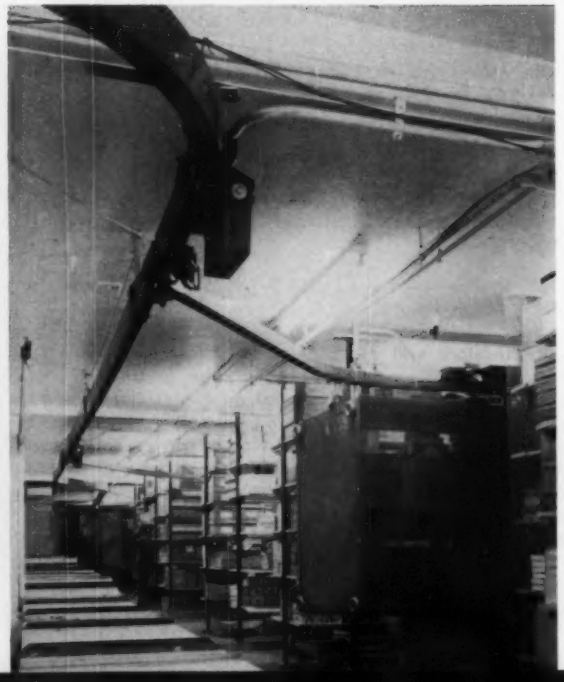
At the store end of the tunnel, loaded carriers may be routed either to basement storage or an *Up* lift, depending upon setting of dial on carrier. Decoding unit on righthand track senses dial setting and operates a conveyor switch that directs carrier either to storage on righthand track or to *Up* lift via spur line. Empty carrier at left is shown leaving *Down* lift for return trip to receiving area. Carriers from basement storage may also be switched onto powered track at left.

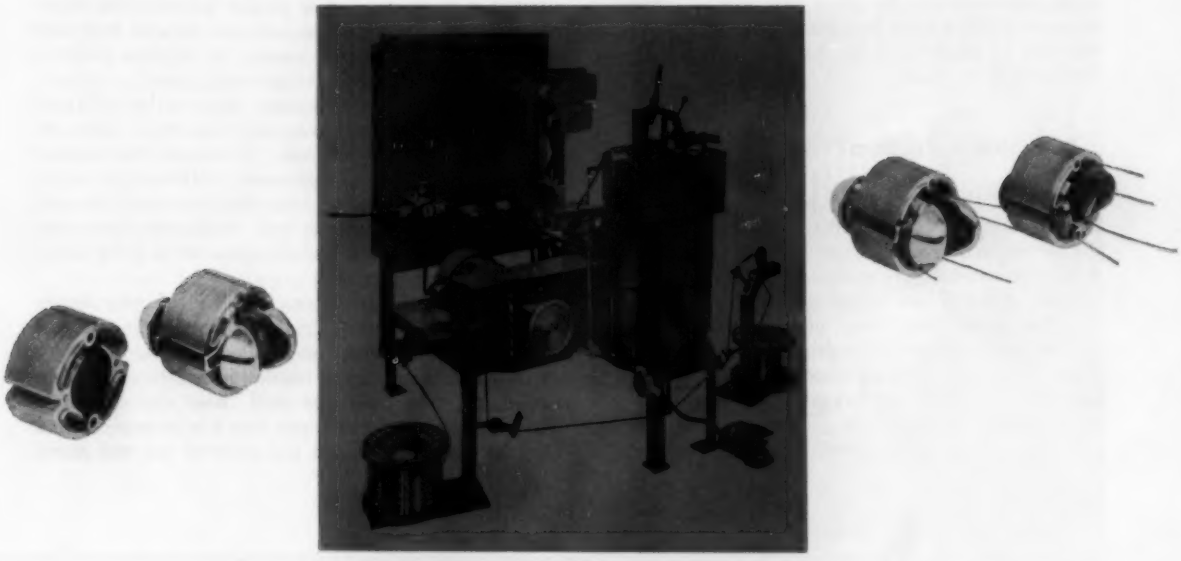
operative efforts of several groups. The powered and free monorail system, elevators, and dispatching controls were designed and built by the Conveyor Div., Columbus McKinnon Chain Corp. The inclined conveyor leading from the receiving floor to the checking area in the service building, and the inclined pipe slide in the latter area, were supplied by Alvey Conveyor Mfg. Co. A New York consultant, Richard D. Elwell, worked closely with W. O. Bode, vice president and general operations manager of Famous-Barr Co. in planning and carrying out the entire project.



8 Loaded carrier is shown leaving *Up* lift at mezzanine level of retail store. From this point, carrier is passed onto powered conveyor rail for transport to stock area where it is switched automatically to preselected free rail section for unloading. If free rail section is full, carrier will circulate on powered rail until free rail is clear.



9 Carrier in foreground has been shunted automatically to a free rail section where merchandise will be unloaded and placed on shelves. When emptied, carrier will be pushed back onto powered rail for return to receiving area in service building. Carrier in background is moving on powered rail to another stock destination on mezzanine above sales floor. Goods are transported to sales floor on any of four elevators spaced around the mezzanine.



WINDING STATOR ASSEMBLIES

Production of small stators is big business even though some designs are produced in lots of a hundred or less. Outlined in this article are some of the considerations influencing production methods, especially those of importance in winding coils directly into stator frames on automatic machines.

By **JOHN F. LILL,** Assistant Manager, Fort Wayne Tool, Die & Engineering Co., Ft. Wayne, Ind.

ASSEMBLY of wound stators for small motors and alternators is a function important to our American way of life. Homes, factories, offices, and automobiles are quantity users of stators in tremendous volume and a variety of designs for vacuum cleaners, fans, food mixers, power tools, etc. One of the most challenging problems in assembly of each stator involves the placing of a great number of loops of electrical wire in slots provided in a stack of laminations.

If the placing of each loop of wire is considered as an assembly operation, the production of stators certainly is a front-runner in any rating of assembly problems on the basis of number of operations required to produce one assembled unit. Even if the placing of an entire coil is considered as only one operation, production of stators deserves a high-difficulty rating since stator designers seem to get preferred functional characteristics by design configurations that are difficult to produce.

Somewhere back in the bygone days of stator production, each individual loop of wire was shaped as it was wound into place manually by a production worker. That method of production was simply not adequate for large scale manufacture, however, and it became common practice to compromise on other considerations so that the electrical wire could be formed into a multi-turn coil on a machine and the coil inserted as a unit into the stator laminations.

But stator producers were not fully satisfied with the results they could obtain by the coil insertion method. One of the results of this dissatisfaction was the development of automatic machines to wind the wire into coils in the desired place in the

stator laminations. In effect this was a combining of some of the design possibilities offered by manual winding in place with the benefits of machine performance of the task.

A Simple Problem?

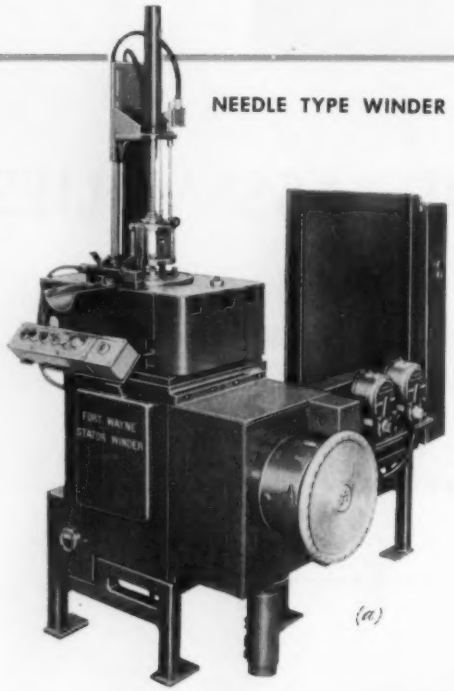
Basically the problem of putting a few loops of wire in some slots can sound rather simple. But when the details required for practical use are added, the actual production problem is seen to be quite involved. One of the complicating conditions is the fact that those "few" loops of wire may actually be several coils involving hundreds of turns per stator.

For instance, a 4-pole stator might require three coils for main windings on each pole plus two coils for auxiliary windings for each pole. Each of the coils for a single pole would be wound into a different pair of slots. For proper polarity, the direction in which successive coils are wound may also need to be varied. A variety of winding patterns are therefore required on a single stator.

In different stator designs, the number of turns in each coil might be specified as units, tens, or hundreds of turns per coil. Whatever the number specified, it must be accurately followed on every coil if performance and cost objectives are to be met. The number of coils per pole might vary from one to five coils per pole, and the number of poles might vary from two to twelve.

For various applications the size of wire might vary from 14 to 40 gage. Regardless of its size, the wire must be introduced into position in the stator without damage to the insulation on the wire or to insulators placed in the slots. Also the coil must be formed in such a manner that it is properly seated in the stator slots, and the ends of the coil turns

NEEDLE TYPE WINDER



(a)

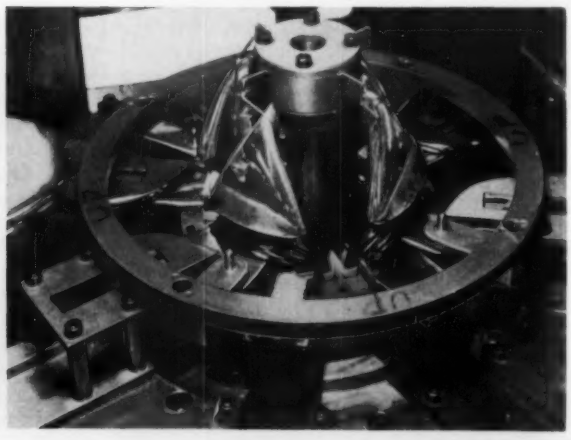
Machine shown in (*a*) was designed from development work done by Fort Wayne Tool, Die & Engineering Co. The stator is manually loaded into the nest, and wire is supplied from spools not shown. This unit is equipped with a pneumatic overhead stator clamp with lift fingers to automatically pull the stator up and out of the winding nest. Additional tooling is also required. Though winding of four poles simultaneously is shown, such equipment is also used for distributed windings on 2-pole stators which are becoming increasingly popular in hermetically sealed motors for refrigerators, etc.

Before the stator frame is placed in the winding nest, coil forming shrouds are manually inserted into the stator, (*b*). Wires are fed through hollow needles that place them in the stator slots and pull them down over the shrouds as in (*c*) to form the coil ends. While one stator is being wound, the operator removes shrouds from the preceding stator and inserts them in the next stator frame.

When the complete winding cycle is finished, the stator is lifted from the nest, and the wires leading to the four needles are cut off, (*d*). These four wire ends are held by the cutoff devices to anchor them until turns have been wound on the next stator. After the shrouds are removed, the wound stator appears as in (*e*).

In the close-ups shown, four poles are being wound simultaneously. Connections between pole windings must then

(b)



(c)

must be of proper height and form to avoid interference with other components.

For flexibility in meeting supply problems that sometimes arise, it is often desired to allow use of a substitute for copper wire such as aluminum wire. However, an aluminum wire must have a larger cross section if it is to have the same resistance as a copper wire. The slots in the laminations must therefore be large enough for the required turns of aluminum wire, and any winding machinery used must be readily adaptable for both kinds of wire.

The reason for putting turns of wire on pole configurations in a stator is to obtain a desired pattern of magnetic flux. Since the physical shape of the stator lamination is an important factor in determining the flux distribution obtained, many varieties of slot shape are used. Most slot designs have a narrow opening which provides access to a larger cavity where one leg of the coil is to be placed. The perimeter bounded by the openings of a pair of slots is greater than the internal perimeter of the coil should be when it is in final position.

Furthermore, in many designs there is practically no opening from the bore of the stator into the space for the coil. Such designs provide little more than holes rather than slots for the coils. In some cases, the stator designs call for additional metal parts to be inserted in the stator slots after the windings are in place. When the winding method used requires such additional components and their insertion, higher costs can be expected.

Also related to the internal perimeter of the coil is the matter of length of wire required for a desired number of turns. The amount of magnetic flux generated is primarily dependent on the number of turns rather than the length of wire in each turn. In an 8-pole motor stator having 30 turns per pole, a saving of $\frac{1}{4}$ inch in the length of each turn could amount to a saving of 50 feet of wire per stator.

Another winding consideration involves the length and outside diameter of the stack of laminations. Since coils pass through the full length of stator frames, the winding procedure must be capable of producing coils of different lengths for various stator designs. Any machinery to be used must also be able to accommodate the specified length and diameter.

In some designs, turns of two adjacent coils share a single slot. In such an arrangement, the turns of one coil lie along one wall of the slot, and those of the second coil along the other wall. Unless there is considerable space left unfilled in the slot, it is es-

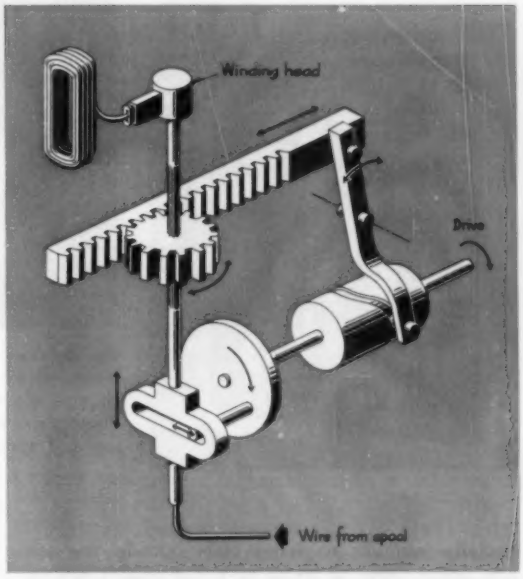
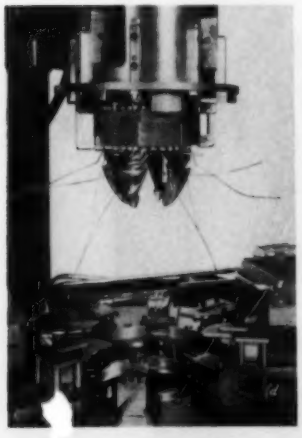


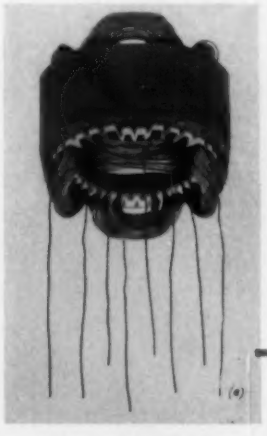
Fig. 1—Needle type winding machines, using the principle shown by the sketch, wind coils of wire directly into the slots of stators. The mechanical linkages are adjustable so that the vertical reciprocation and horizontal oscillation of the winding head can be varied to suit the desired configuration.

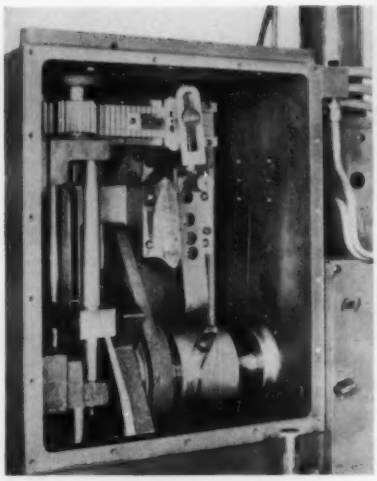
be made in succeeding operations. The needle winder can also be supplied as an indexing unit which winds one coil at a time and then indexes to wind the next coil. Since the coils are wound with a continuous strand of wire in that procedure, they are already connected.

Winding speeds of approximately 500 winding head cycles per minute were attained on the first Fort Wayne needle winder. Today, speeds of 1000 winding head cycles per minute are normal on a range of stator winding operations without excessive stress on the mechanism or damage to wire insulation. In fact, the higher speeds normally result in a more orderly and compact wire lay.

Some current plant production figures indicate what present winding speeds mean to manufacturing capabilities. One machine, capable of operating at 300 to 600 winding head cycles per minute, winds 4-pole shaded pole stators at a rate of 120 units per hour, all poles wound simultaneously with 150 turns of 22-gage wire. Another machine, capable of operating at 700 to 1000 winding head cycles per minute, winds 4-pole shaded pole stators at a rate of 200 units per hour, all poles wound simultaneously with 150 turns of 28-gage wire. Machines capable of operating at 250 to 400 winding head cycles per minute wind 4-pole stators with three group concentric coils at a rate of 88 stators per hour, with 30, 40, and 55 turns of 20-gage wire per pole.







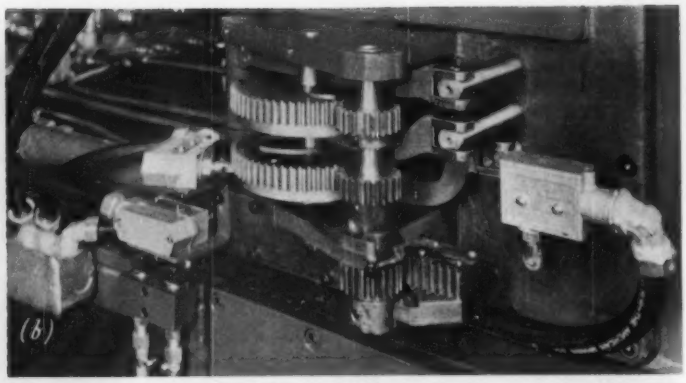


Fig. 2—View at *(a)* shows drive mechanism to perform the winding action indicated in *Fig.* 1. Some machines can be set up to automatically change the arc of oscillation at selected points in the winding cycle. Photograph at *(b)* shows such an oscillation change device to wind varying coil spans of distributed-type stators.

pecially difficult to wind coils outside the stator and insert them as units in a shared-slot design.

Another coil winding factor worthy of mention is the control of tension exerted on a wire as it is wound into a coil. To pull a wire into position and make it lay smoothly in place, tension is applied. An excess amount of tension, however, breaks the wire or stretches it and reduces its cross section. As long as the tension is not great enough to seriously weaken the wire, its insulation, or other elements, uniform tension and uniform reduction in cross section can be taken into account in designing the stator. But when the tension goes up and down during the winding of a coil, resistance changes are not uniform, and performance characteristics are adversely affected. Since most coils are roughly rectangular in shape, it is very difficult to maintain uniform tension as wire is successively wound around the corners.

Before the stator can usefully function, leads for the ends of the coils must be brought out and properly connected. Where a multispeed motor stator is being wound, taps must also be pulled off after a specified number of turns within a coil. Repeatable accuracy, in pulling taps after the specified number of turns, is required if performance consistent with specifications is to be obtained. The winding procedure must also provide these leads and taps at the proper points and of desired length.

▶ Make Them By Machine

At the end of World War II, manufacturers of small stators were faced with a tremendous volume of back orders. By and large, stator winding had continued to be a tedious time and labor-consuming job. Some progress had been made in mechanized winding on large motors, but methods for volume production on small motors had been given little attention.

It was in this area of production that the situation became most critical. Demand was increasing. Labor costs were mounting. Skilled workmen for this type of operation were at a premium. Outside manufacturers with cheaper, more abundant workforces were moving into this lucrative market.

In 1946, Fort Wayne Tool, Die & Engineering Co. received an assignment to produce a machine that would automatically wind fractional horsepower motor stators. The machine was to meet these requirements: Wind the wire directly into the stator slots at high speed; wind all poles simultaneously; be readily adaptable to a variety of stator types.

The sample supplied by the manufacturer was an

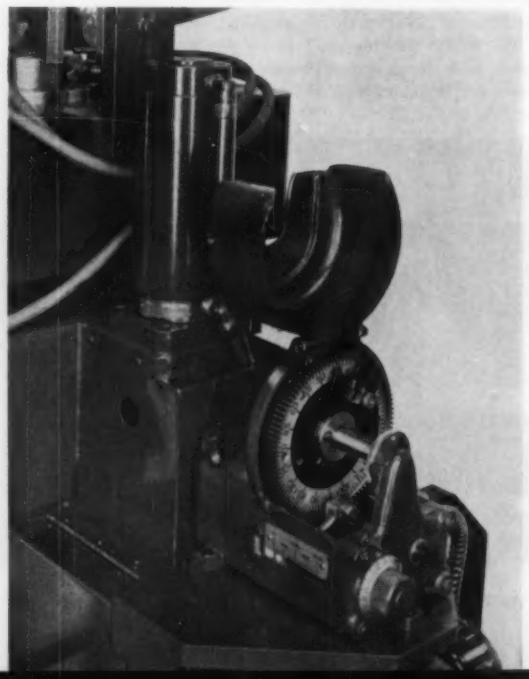


Fig. 3—A pre-set mechanical counter senses the number of winding head cycles performed and initiates indexing or cycle stopping actions. The Counter & Control Corp. unit shown can be set to trip at 0 to 2000 counts, and it automatically resets.

8-pole motor stator requiring a high number of turns of 36-gage wire. After a period of intensive development, a machine was produced to automatically wind those stators. The introduction of automatic winding methods brought a new concept in production potential. With this machine, average winding rates were 100 stators per hour on frames requiring 300 turns per pole.

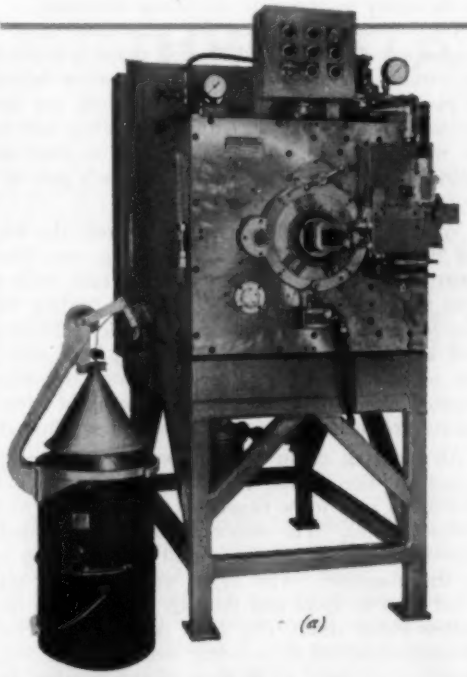
Development of devices continued in order to make the operations more automatic and improve the product. A continuous indexing mechanism was built into the machine to make connections between coils as a part of the winding cycle. This was accomplished by completing the entire winding operation with one continuous strand of wire and in such a way that alternate poles were wound in a reverse direction to provide proper polarity. Also developed were an automatic lead cutting and anchoring device, a unit to automatically pull taps for multispeed motors, and coil forming shrouds to help shape the coil-ends.

Availability of such winders allowed a revision in motor design practice. In some cases the same horsepower could be attained in a smaller stator, or the horsepower output could be increased without changing the frame size. Savings could also be realized by reduction in wire requirements and elimination of mechanical parts in the stator.

▶ Standard Machines

As a result of the work carried on, Fort Wayne Tool, Die & Engineering Co. has developed three basic types of standard machines to wind stators—simultaneous needle type, indexing needle type, and chain type.

The simultaneous and indexing needle types, *see box*, are based on the same operating principle. A stator to be wound is mounted in a fixture with



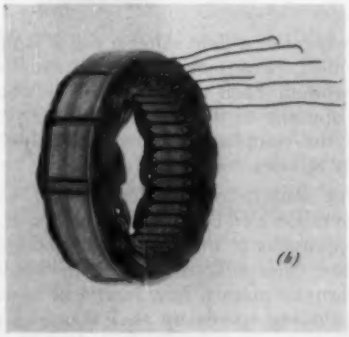
(a)

CHAIN TYPE WINDER

Recent development in stator winders is the chain winder in photograph at (*a*). The particular unit shown is set up for production of 12-pole, 3-phase stators for automotive alternators (*b*). The stator frame is loaded into the front of the machine and manually clamped in the winding nest. Wire is fed from the supply at left, through a tension device, and through a winding eye.

The winding eye is a hollow pin in the endless roller chain partly visible in the close-up at (c). As the chain is moved around its path, the winding eye deposits the wire as a coil in the appropriate pair of slots in the stator frame. When the prescribed number of turns is wound on a coil, the hook device shown pulls a loop to the right to form leads to that coil and the next coil. The winding nest is then automatically indexed and the next coil wound in the opposite direction.

In the application shown, three different types of coils are wound in the coil slots. Outer coils are all wound into the slots, then the winding device automatically adjusts to wind the intermediate coils, and it adjusts once more to wind the inner coils. Start and finish leads between the coil groups are automatically cut as winding progresses. At the end of the complete winding cycle the operator manually releases the stator.



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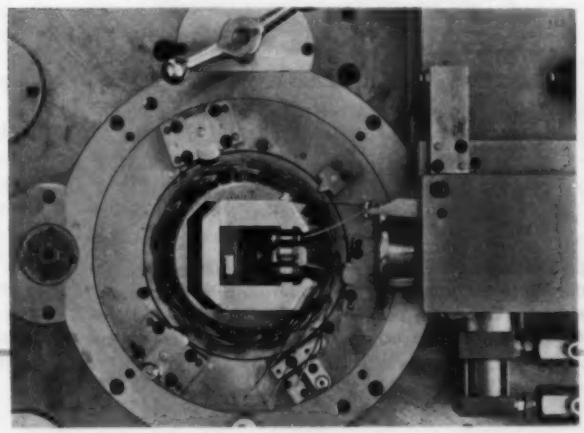

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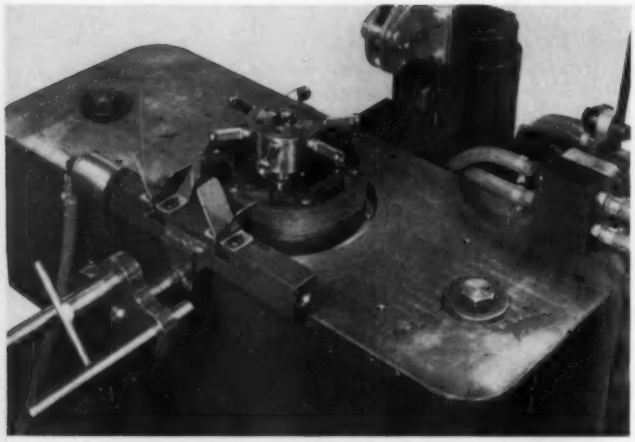

Fig. 4—Six-pole stator frame is shown in position in the winding nest of a needle winder. In operation, an overhead clamp holds the stator in the nest. Coils are wound on all six poles simultaneously in this application. After it is wound, the stator is placed on the bars at lower left to pull out lead wires and hold them while the next stator is started. The lead wires are automatically cut by the cutting device along the front edge of the work surface.

the axis of the stator vertical. Wire to be wound on the stator is fed up through a hollow vertical shaft and out through a hollow needle, *Fig.* 1. The needle is narrow enough to fit through the slot opening in the stator. The machine mechanism reciprocates the shaft vertically and also oscillates it about a vertical axis. The point of the needle is thereby moved up through one slot, over to another slot, down through the second slot, and back to the first slot so that it describes the desired path for one turn of the coil.

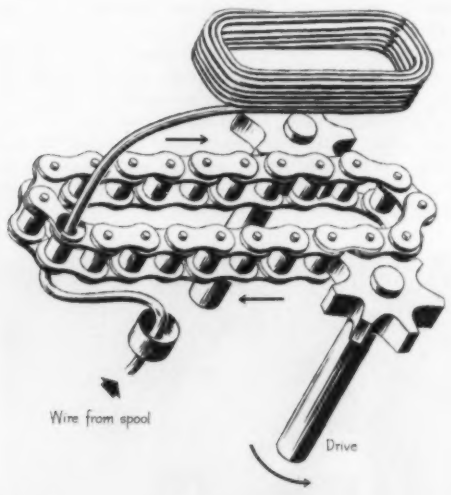

Fig. 5—Chain type winding machines place wire in stator slots by means of the operating arrangement sketched. Only one coil is wound at a time, and the winding nest is indexed so that succeeding coils can be wound.

These winding motions are controlled by straight mechanical devices, *Fig.* 2, and each motion is adjustable for adaptation to various stator types. A predetermined counter, *Fig.* 3, is used to count the number of cycles completed by the winding head, and initiate the next step of the winding sequence. The counter is adjustable from 0 to 2000 cycles. Correct tension is maintained by means of a special ball device through which the wire is pulled.

In the simultaneous winder, a needle is provided on the winding head for each coil to be wound, *Fig.* 4. A similar number of spools of wire are required so that each needle is supplied with a strand of wire. One cycle of the winding head thus places as many turns of wire as there are needles.

The indexing needle winder is used for stators where the number of coils is an integral multiple of the number of needles. After the winding head has performed the specified number of cycles, the machine indexes, and the winding head is again cycled. This procedure is repeated as many times as necessary to complete the stator windings.

In the needle winders, the individual turns are guided into the slots, and the coil shape is controlled by shrouds manually inserted in the stator before it is placed in the machine. The shrouds are automatically clamped in place during winding, and must be manually removed from the stator after it is wound. One shroud is required for each pole to be wound during the machine cycle.

When a wound stator is removed from the winding fixture, it is placed in a receiving nest. Movement of the stator to the receiving nest pulls out wire for leads of desired length. The trailing wires also fall into an automatic cutoff device. However, they are still attached to the winding head and are not severed until the succeeding stator is partially wound. The need for manual anchoring of wires at the start of each winding operation is thus eliminated.

An indexing chain winder, *see box*, is the most recent addition to the Fort Wayne line and is the first of its kind to be developed and patented in the United States. The stator frame to be wound is mounted with its axis horizontal in a winding nest on the machine. Wire to be wound on the stator is fed from its spool and through a hollow pin in an endless roller chain, *Fig.* 5. A coil-forming shoe is an integral part of the winding element; therefore, no loose shrouds need to be inserted and removed from the stator.

One coil is wound at a time. After a coil is wound, the winding nest is automatically indexed, and the next coil wound. Each successive coil is wound in a direction opposite to that of the preceding coil. At the end of the complete winding cycle, the operator manually releases the stator.

This machine was originally designed to wind small instrumentation and control unit motors. Having met all requirements in exhaustive production tests, it has now been adapted for use in winding automotive alternator stators. Low inertia of moving parts permits winding speeds up to 1000 turns per minute. The chain type winder is also adaptable for winding stators with skewed slots.

Fig. 1—Parts typified by this flywheel housing are processed by 3-station numerically controlled machine. A starter pinion hole and three mounting bolt holes, shown by the outline, are machined. Different styles and models of engines require that the pinion hole be located in different places and that the three bolt holes have a different orientation around the pinion hole.

PUNCHED TAPE DIRECTS THREE-STATION MACHINE

Where job-lot requirements are found, a potential application of numerical control can be found. And the versatility of numerical controls means that manufacturing engineers need not be bound by conventional thinking in applying such controls. As an example, consider this special machine in which parts are indexed beneath three machine heads in a tape controlled setup.

AS ACCEPTANCE of numerical controls spreads, the adaptability of the concept in improving production operations is emphasized. This is evidenced not only by the variety of equipment types which can be controlled, but also by the manner in which proved usages can be varied to meet special problems. A case in point to illustrate this latter aspect is to be found at Detroit Diesel Engine Div. of General Motors Corp.

As part of an extensive machine tool program aimed at developing a flexible production facility for manufacture of 15 different basic diesel engine designs, the company has installed a 3-station machine that includes a numerically controlled index table. The effect achieved is that of a small in-line transfer machine in which a variety of part styles are moved under three separate machine tool spindles by a numerically controlled positioning device. The machine was furnished by National Automatic Tool Co. Inc.

This article is based in part on information obtained from a paper entitled "New Techniques for Production Flexibility," by C. J. Karrer, Master Mechanic, Detroit Diesel Engine Div., General Motors Corp., presented at SAE Detroit Section meeting, Nov., 1959.

The 15 diesel engine designs are offered in over 400 separate model forms to satisfy the many different applications of diesel engines. In addition to obvious differences in cylinder sizes, etc., the models differ in such regards as direction of crankshaft rotation, exhaust and air intake location, and the location of the starter, oil cooler, and other accessories. Only by the co-ordinated effort of the product design function and production engineering function were the extensive metal cutting problems associated with such a variety of parts reduced to economical proportions.

The parts machined on the numerical controlled 3-station machine are the flywheel housings that are used on 13 of the 15 engine designs. A typical part is shown in *Fig.* 1. The specific operations performed by the machine are to rough and finish bore and chamfer a starter pinion hole and to drill and tap three holes around the pinion hole for starter mounting bolts. The starter pinion hole might be located at any one of six different radial distances from the crankshaft centerline and also varies circumferentially about the centerline depend-

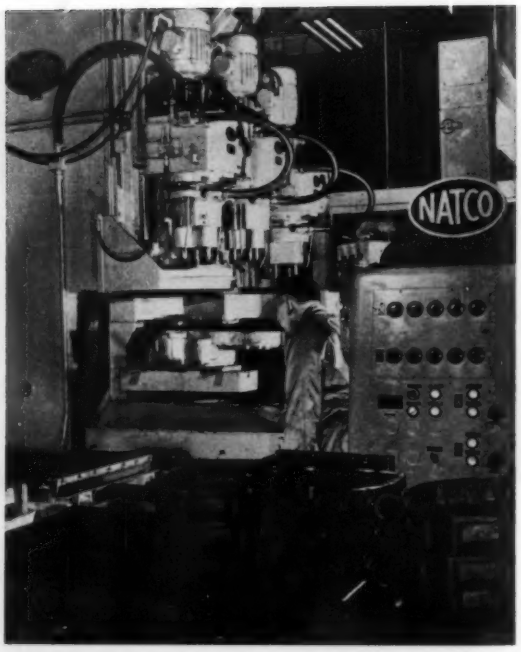

Fig. 2—Parts move to machine by roller conveyor. Individual parts are raised by an elevator mechanism to fixturing height. Part is shown mounted in bridge-type fixture and beneath first of three stations through which it will pass. Position table has a 72 by 30 inch travel capability.

ing on the desired location of the starter in the vehicle in which the engine is to be mounted (for both left and right hand mounting). In addition to these variables, the circumferential location of the three mounting bolt holes, at a fixed radius from the starter pinion hole, can vary. Considering all variables, over 160 versions of housings in cast iron or aluminum are involved.

The various styles might be processed in lot sizes ranging from 10 to 500 parts. In operation, the parts are delivered to the machine area by roller conveyor, *Fig.* 2. Individual parts are, in turn, raised to fixture height by a pneumatically operated elevator mechanism and then slid into and clamped in the fixture. With the proper machine head orientation and with the proper tape in the reader, a start button is actuated, and the tape control takes over.

The basic portion of the 3-station machine, *Fig.* 3, is made up from three standard columns, slide units, and slide unit controls. At the first station the starter pinion hole is bored to size, the pinion hole is chamfered, and the three bolt holes are center drilled. At the completion of these operations, the part is indexed to the second station where the three bolt holes are drilled. At the third station the three holes are tapped. Hole locations are held to a tolerance of ± 0.005 inch. The part is then cycled back to the load-unload point and removed from the fixture. Machine cycle time is on the order of $3\frac{1}{2}$ minutes.

Programming required for this application is simple and straightforward. The table always approaches the desired end points of travel from the same direction. Rapid traverse is at a rate of 160 ipm; this is stepped down through four speed ranges to 0.3 ipm for the approach rate of travel. The zero reference point of the table can be established anywhere within the machine. With the center line of the crankshaft as a zero point, the *Y* co-ordinate for the first station can be read directly from a blueprint. The *X* co-ordinate can then be simply determined. The arrangement of the machine is such that the *Y* co-ordinate is the same

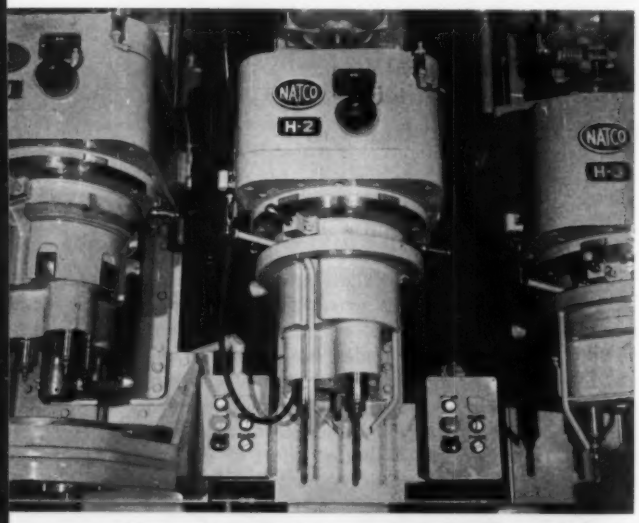

Fig. 3—Three machine heads illustrated provide for: Boring and chamfering pinion hole and center drilling three holes (left); drilling three holes (center); and tapping three holes (right). In each head, the spindles for the three-hole operation can be repositioned as a unit to obtain a different orientation of the three holes relative to the fixtured part.

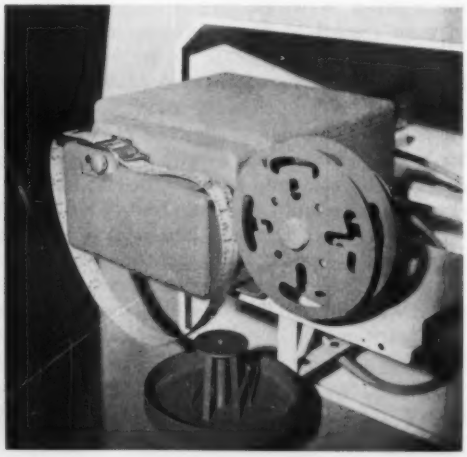

Fig. 4—Information to direct the machine operations for a given part is punched in a 1-inch wide, 8-level tape. Loop of tape provides for constant recycling of instructions in processing batches of like parts.

for all three stations; the X co-ordinates of the second and third stations are at fixed distances (24 and 48 inches respectively) from the calculated X co-ordinate of the first station. As a matter of convenience in processing batches of a given part, the tape for the parts is looped for repetitive cycling, *Fig.* 4.

So far as changeovers are concerned, changing tapes is only a matter of several minutes. As shown in *Fig.* 3 each machine head is equipped with a ring dial which aids in locating the drill spindles. When the relocation of the three bolt holes about the center line of the starter pinion hole is required, the operator must manually unclamp, rotate, and reclamp the spindle head in the desired position. This adjustment should not exceed three minutes. A control console permits the table to be positioned by control dials when tape control is not desired.

S. J. Hunt, vice president, engineering, National Automatic Tool Co. Inc., comments on numerical control . . .

Potentials of point-to-point systems. "There has been a great deal of publicity on continuous path control of machine tools by numerical control. This is perfectly understandable. It is more glamorous and fascinating. It also comes close to actually accomplishing a job which cannot be done by a manually controlled machine; it also is very expensive. However, I am convinced that there is actually a greater savings to be made by a point-to-point numerical control system. There will not be the fantastic savings per piece as has been shown by some of the large profile milling machines. But, because the initial cost is much less for the point-to-point system, it can be purchased and used by a much greater number of shops. A two axis point-to-point control can be purchased for $10,000 to $15,000. This, of course, being in addition to the cost of the machine tool. Hundreds of shops can afford this kind of money, and in practically all cases a real savings can be shown."

Practical aspects of accuracy. "When the project of designing a point-to-point system was initiated, our philosophy was that a system should be designed to sell for a price that could be afforded by the average manufacturing company. We were willing to concede some accuracy for an important reduction in cost. To have merit, the system had to have an accuracy of at least ± 0.005 inch. A great amount of work is produced within this accuracy. Naturally ± 0.003 inch covers a broader range if it can be achieved without significant increase in cost; and ± 0.001 inch covers still a broader range. Jig borer accuracy of ± 0.0001 or 0.0003 inch is required on military or aeronautical equipment, but we reasoned that the additional cost the customer would have to pay for this accuracy would eliminate a large share of the potential market. So far we have only had one customer who was thinking in terms of anything more accurate than ± 0.003 inch. This accuracy thing is relative and until we actually start talking in dimensions, we will get no place."

Speed of movement. "We expect to sell numerically controlled machines on an economic basis; in short, a reduction of piece cost for our customer. Speed has been entirely experimental on our part. We began by shooting for 200 ipm at high traverse rate. For a number of reasons we have so far found approximately 150 ipm to be our maximum for reliability. This speed, of course, means very little on short index but we have been aiming at larger work—36 and 45 inch travel—and speed means more for these distances than it does for smaller travels. Also it seems to us that the problem is more psychological than factual. When a man operates a manually controlled machine, the speed of traverse is often overlooked because the man appears constantly busy. When the table is automatically controlled, the operator is not busy, and all attention is focused on the delay while waiting for the table to position. In other words, the delay is emphasized and seems much greater, even though it is a fraction of the time of conventional machines."

What can be expected. "Application of numerical control is unlimited. Nearly any movement can be programmed although it is not always economical to do so. Very often a certain machine adjustment is necessary only once a day or once a week, and this would be very expensive to tape control. The correct economical answer can be decided only after an extensive study by the builder and the user. However, in our own shop, on our tape controlled table located under a standard radial drill with no fixtures required, we are successfully competing with fixtured parts. In comparison to previous jobs on unfixtured parts, we are producing at savings as great as 40 per cent. In other words, we can completely eliminate the cost of the fixtures; and on parts where production quantities do not warrant fixturing, we can save 40 per cent of manufacturing costs. We are continuing to improve the equipment, and I guarantee the per piece cost will be reduced to an even greater degree. For instance, we have decided how we can expand a number of operations to include not only drilling, tapping, and reaming but also milling. We have also decided that changing tools is done much better by a tool changer than through the means of a turret. Most important reason for this is that it is much more accurate and that it's practical to put 32 tools on a changer while a turret only holds a maximum of 8 tools."

Standardization. "There has been much talk for the past two years on standardization: Standardize the tape, standardize the code, standardize the components. I will fight this at every turn whenever I get the opportunity. I am a member of several standards committees including that of the NMTBA, and I have come to realize there are benefits to be gained when the time is right and the art is developed. Now, is not yet the right time! Improvements and developments are being made daily. The very fact that the costs of computers and other tape preparation equipment is so high is a very good reason for not standardizing. Give us ample opportunity to develop and improve these devices before we insist on them all being the same. In our system for example, we don't need magnetic tape so why insist on it. A special machine may have any number of motions tape controlled so why limit the number. In my opinion it will be a minimum of at least 5 years before standardization can be pursued with any intelligence."

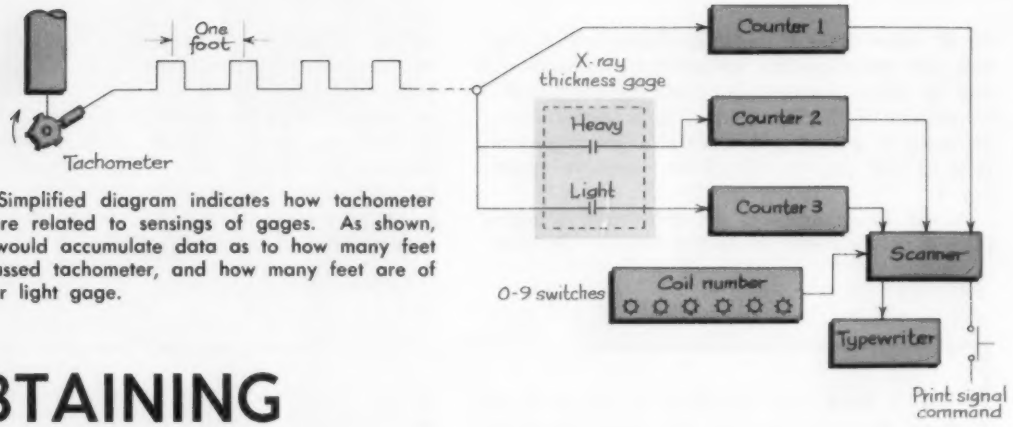

Fig. 1—Simplified diagram indicates how tachometer pulses are related to sensings of gages. As shown, system would accumulate data as to how many feet have passed tachometer, and how many feet are of heavy or light gage.

OBTAINING INFORMATION DELAY IN AUTOMATIC SYSTEMS

By G. E. TERWILLIGER, Industrial Analytical Engineer, Industrial Engineering Section
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ONE of the problems associated with automatic inspection systems is the determination of techniques to be used in collecting and recording of inspection data. The problem has increased in importance with the trend toward the use of continuous production, with greater production speeds of which equipment is capable, and with the realization of the advantages in having digital data immediately available in a usable form requiring no editing. Continuous production of strip, in which several parameters must be checked, can illustrate some of the aspects of the data handling task in a digital system to highlight the complexities which can be encountered. A modern tinplate line is an excellent example of such a strip processing operation (see box entitled "Continuous Production of Tinplate"), though equally good examples can be found in the paper, textile, and rubber industries.

The inspection instruments used on a tinplate line, and their functions, include the following: 1. X-ray thickness gage which measures the base metal strip thickness. 2. Pinhole detector which inspects

CONTINUOUS PRODUCTION OF TINPLATE

TINPLATE is one of the major classes of products produced by the steel industry. In the production of tinplate, the basic metal is hot-rolled from slabs, continuously pickled, cold rolled, cleaned, annealed, temper rolled, and then delivered in coiled strip form to a tinning line where the coating of tin is to be added.

Two methods of coating the strip are in use: The hot-dip method, in which the steel strip is passed through a molten bath of tin, and the electrolytic method, in which a thin coating is deposited on the strip by electrochemical means. The latter process is a closely controlled operation in which a very uniform coating of tin is obtained. The controllability of an electrolytic line is emphasized in the diagram of a tinning line accompanying this box, illustrating as it does a type of line in which a different thickness of tin can be added to either side of the strip being processed.

In the operation of a line typified by the diagram, the free end of a coil of strip to be plated is welded to the end of strip being plated, without stopping the line. The looping pit holds a free length of strip from the old coil to allow continuous operations for the few seconds required to weld the two strips and accelerate the new coil to processing speed.

After passing through the cleaning zone, the strip moves into the first plating section in which tin is to be deposited only on the bottom of the strip. The necessary plating circuit is established through the strip by means of negatively charged rolls in contact with the strip, the electrolyte, and pure tin anodes immersed in the electrolyte. The strip is reversed in direction before entering the second plating section, thus presenting the other side of the strip as the bottom side to be plated. The freshly plated strip, lacking the luster associated with tinplate, is subsequently passed through a reflow coating operation in which sufficient heat is applied to make the tin coating flowable. After quenching, the luster

In many automatic processes, information obtained in one part of a system must be delayed for a controlled period before it is used by another part of the system. By what techniques can a controlled delay be obtained? Highlighted in this discussion of a data logging system for a tinplate line is a magnetic drum technique that is both economical and reliable.

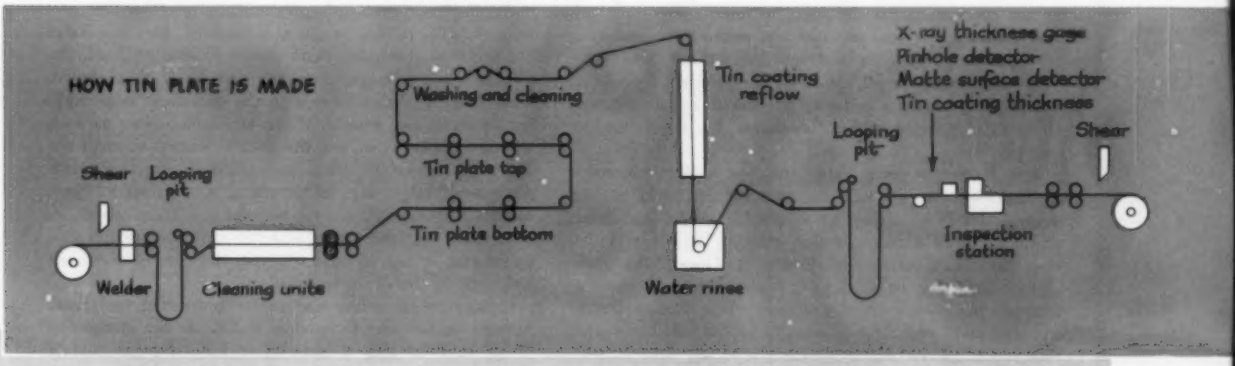
for small holes (down to 1 mil) in the steel base. 3. Coating thickness gages which measure the thickness of top and bottom tin coatings. 4. Surface inspection devices which measure quality of tin coating. 5. Measuring roll and pulse tachometer which indicate strip length. There are also manual input stations where observed surface defects and coil identification data can be introduced into the data collection system. The several instruments and data input means are located at various points along the tinning line.

Assuming satisfactory operation of the inspection equipment, the data logging problem is one involving position and time: A given segment of strip is inspected at various points along its line of travel, but until it has passed the shear point it can possibly end up in one of two different coils. Thus, the automatic data logging system must receive an inspection signal for a segment of strip and temporarily store the signal until it can be related to a specific coil.

As strip is processed, the inspection data supplied by the various sensors are automatically logged on a per foot basis and, depending on the types of defects noted, a quality determination for each foot of tinplate is made. With the operation of the shear at the end of the line, a signal is sent to the data logging system for it to read out that portion of the accumulated data pertinent to the completed coil and to start totaling data for the new coil being formed by the continuously advancing strip. The readout data for a coil are presented on one line across a record sheet and, as the data are being typed, a punched paper tape or card also can be produced if desired.

▸ Basic Approach

The means of measuring strip length is a basic part of the digital data logging system and is closely tied into other inspection equipment. This is shown by *Fig.* 1 in which, for purposes of explanation, it



is obtained. Following minor preparation operations, the strip is recoiled, the rear looping pit permitting coil changeovers without stopping the line. The coil is weighed and made ready for shipment to a user.

In general, the recoiling of the finished tinplate for direct shipment to a customer is a relatively recent innovation, the standard practice having been to cut the strip into small sheets at the mill. As a matter of economy, some users now purchase large coils which may contain from 10,000 to 30,000 feet of tinplate 20 to 48 inches wide, where before they purchased wrapped bundles of sheets mounted on skids. This change has introduced several problems for steel plants. Formerly, when sheet forms were sold, it was possible to inspect small units of production at the end of the line and classify them to insure that no defective material was shipped. Now, when coil forms are shipped, both good and bad material is delivered to the customer. The problem for the steel plant, then, is one of inspecting a web moving at line speeds of 1200 to 2000 feet per minute and logging the inspection data in a form suitable for quality control and accounting purposes.

Highest quality, or "prime", plate is that strip that is within the desired gage tolerances whose surface is flawlessly covered with the desired thickness of tin. By trade usage, strip of desired gage with only superficial coating defects is classed as "menders." A third classification, "waste-waste", covers that part of the strip that is outside gage tolerances, that contains glaring surface defects, or that contains perforations in the steel base. Thus, the inspection and data handling systems provide data to prepare the following report for each coil: Identification data; total feet of strip; total feet of prime strip; total feet of mender and waste-waste strip; total feet of heavy and light gage strip; total feet containing pinholes; total feet of strip with underweight tin coating; total feet with surface defects; coil weight; and time.

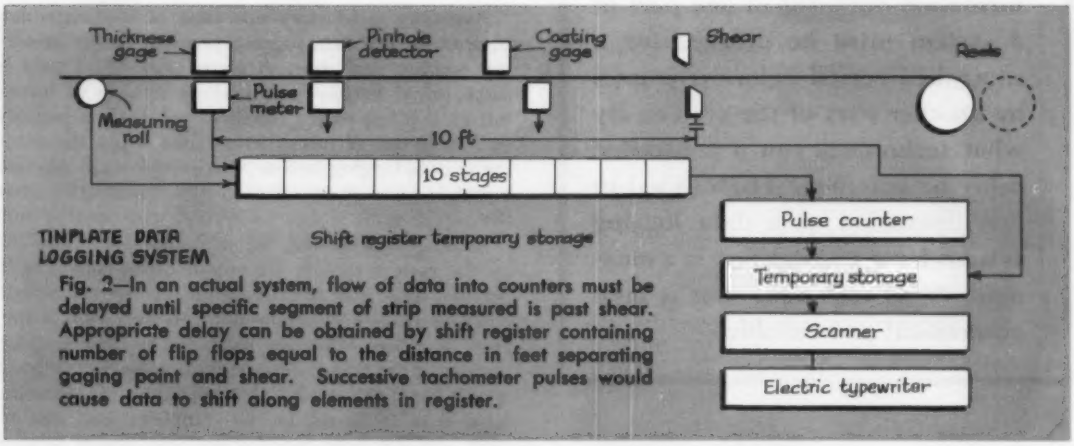


Fig. 2—In an actual system, flow of data into counters must be delayed until specific segment of strip measured is past shear. Appropriate delay can be obtained by shift register containing number of flip flops equal to the distance in feet separating gaging point and shear. Successive tachometer pulses would cause data to shift along elements in register.

has been assumed that the problem is simplified to that of indicating total length and also accumulating data as to how much of the length is light and heavy gage.

Essentially, the measuring system involves a measuring roll that has an accurately machined circumference of, for example, 5 feet. This roll contacts and is turned by the moving strip. Connected to the roll is a pulse tachometer, shown by the star wheel, that will give 5 output pulses to the system

MAGNETIC DRUM FOR DATA DELAY

A MAGNETIC DRUM technique that finds wide usage is known as the data track revolver. The main advantage of this technique is based upon the ability to read recorded data on the drum and, at an equivalent position on the opposite half of the drum, to simultaneously record new data. A revolver requires two recording heads—one for reading stored data and one for writing new data. With additional circuit elements, the revolver technique will allow a magnetic drum to be used as a shift register. How this is accomplished is shown by the following example.

The diagram accompanying this box indicates a magnetic drum rotating clockwise. Among the tracks on the drum is an Index Track on which is recorded two bits, or marks, exactly opposite each other. These marks divide the drum into halves. Beside the Data Delay track on the drum to be used as a shift register there is a separate Marker, or Timing Track. The Timing Track contains prerecorded marks equally spaced relative to the two index marks which divide the drum into halves. This is illustrated in the diagram by the numbers 1 through 6, which are recorded on both halves of the drum, or, in other words, with proper read heads the timing track amplifier will indicate six impulses between each index pulse. This arrangement provides for the control and location of variable data to be stored on the Data Delay tracks. In the diagram, variable data bits are shown by alphabetical notations and are to be thought of as data indicating whether or not specific one-foot sections of tinplate have contained flaws. For instance, if *A* is a north magnetized spot this could mean that the first foot of tinplate is off-gage; if *C* is a south magnetized spot this could mean that the third foot of tinplate is on gage; etc. It should be noted that this data will line up with pulses recorded in its associated Timing Track.

As the drum revolves, the normal path for the flow of data is in accordance with the diagram and switches in the position shown. As each timing impulse is sensed by a read head, its associated data bit is sent from the read amplifier to the write amplifier and the data is immediately re-recorded in an equivalent position on the opposite half of the drum.

Assume now that *G*, representing a new one-foot section of strip passing a gage, is inserted into the Extra Storage. As the index mark passes its reading head, the switches will change their position from that shown. This adds the Extra Storage to the data flow loop, making it seven bits instead of six bits long. Now as each timing impulse is sensed, the data is shifted through the Extra Storage before being re-recorded on the drum, with the overall effect that in six shifts, *A* ends up in Extra Storage and *G* ends up on the drum. Thus, when the next index impulse occurs and the switches are returned to normal, *A* can be extracted from the data delay system and sent to the drum counter.

Continuing in a like manner, *H* is inserted into Extra Storage on the next tachometer pulse. At the completion of six shifts of bits, *B* ends up in Extra Storage, and *H* ends up on the drum. Thus, for the example, data is delayed by six tachometer pulses before it is sent to the counter. This would correspond to a situation in which the gage was located six feet from the shear, requiring data to be stored for six tachometer pulses before being counted.

An actual data delay track for the magnetic drum used in a tinplate data logging system holds 480 bits. This capacity can be used for one inspection device, or it can be divided between several devices, the number of bits assigned to a device being equal to length of delay required. When a track is shared, electronic circuits provide that information from each inspection device is in its turn processed to proper counters between successive tachometer pulses. Where one track with 480 bits is not sufficient for one device, i.e. if a thickness gage is 580 feet from the shear, part of the delay can be obtained on one track and the remaining delay on a second track.

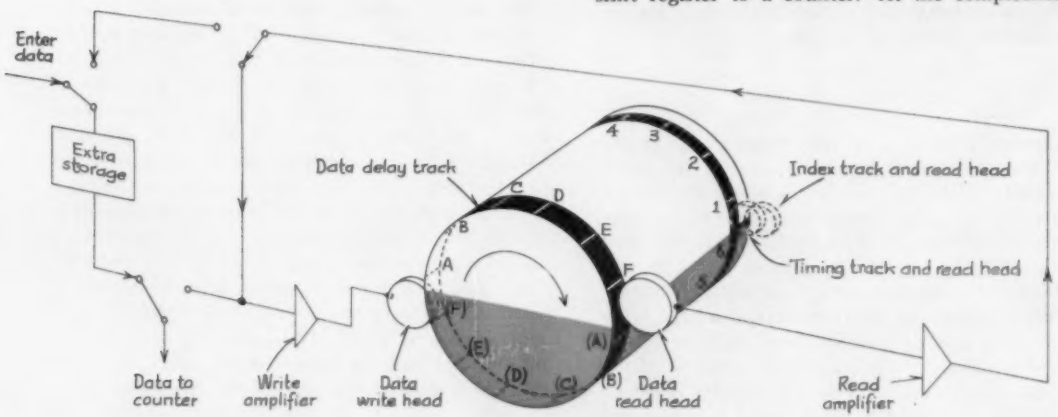
for each revolution of the shaft. Thus, an impulse is created for each foot of strip that passes the measuring roll. This impulse is counted by Counter 1 to indicate total length.

The thickness gage includes provisions to operate normally-open contacts placed in parallel circuits connecting the tachometer and Counters 2 and 3. When off-gage material is detected, the proper contacts are closed, switching the impulses into the proper counters. The count stored in these counters will indicate the number of feet of off-gage material that has passed the gages.

The diagram in *Fig.* 1 also shows a manual input panel by means of which an operator can insert fixed data, such as customer order number, into the system. The pushbutton is provided to control the starting of the system's scanner at the completion of a run or cycle. With pushbutton actuation, the footage values logged in the counters can be transferred to the automatic typewriter.

As previously discussed, in an actual tinplate line it is necessary to compensate for the physical spacing separating the inspection instruments and the shear. Before the impulses can be counted as representing defects in a coil, the inspected strip must have passed the shear.

As a means of temporarily storing the impulses, a shift register, *Fig.* 2, can be used to delay the data until the sensed defect on the strip is beyond the shear. A shift register for delaying the signal from a particular gage in a per foot system will contain a number of stages equal to the distance in feet separating the gage and shear. The unit can be thought of as the equivalent of a conveyor belt synchronized with the movement of the strip. With successive tachometer impulses, the signal representing a defect is successively advanced, or shifted, through the various stages of the register. As the strip passes the shear, the signal is taken from the shift register to a counter. At the completion of a



TACHOMETER PULSE	INDEX PULSE	TIMING PULSE	IN EXTRA STORAGE	LOCATION OF DATA ON DRUM 1 2 3 4 5 6	1 2 3 4 5 6
			Enter → G	F E D C B A	
X	X	1	F	E D C B A	G
		2	E	D C B A	G F
		3	D	C B A	G F E
		4	C	B A	G F E D
		5	B	A	G F E D C
		6	A		G F E D C B
	X	1	Extract ←	G	F E D C B
		2		G F	E D C B
		3		G F E	D C B
		4		G F E D	C B
		5	Enter →	G F E D C	B
X	X	6	H	G F E D C B	
		1	G	F E D C B	H
		2	F	E D C B	H G
		3	E	D C B	H G F
		4	D	C B	H G F E
		5	C	B	H G F E D
	X	6	B Extract ←		H G F E D C

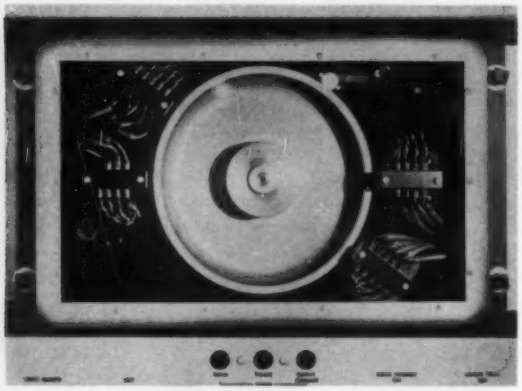


Fig. 3—The magnetic drum used in the data logging system is 8 inches in diameter and 2 inches wide. Across the 2-inch width, 32 tracks of information can be recorded. As illustrated, read and write heads are paired, with a read head located exactly opposite a write head. This arrangement allows information to be read, manipulated, and re-recorded without disturbing its location relative to an index mark.

coil (generally, just after the weld which marks where two strips were previously joined) the shear is operated. This also results in a signal causing the data in the various counters to be read out into a temporary storage to await printing. At the same time the counters are reset to zero so that data can be collected on the new coil. The shifting of data from the counters to the temporary storage is so fast that it is accomplished between tachometer impulses. The scanner, also started by operation of the shear, then scans the data in the storage registers, the fixed data indicated by the selector switches, and a clock, feeding the data to the electric typewriter and other output devices.

Considering the need for separate signal channels and, for each channel, the need for a separate stage for each foot of distance each signal must be delayed, it is apparent that the number of components with a shift register system will be sizable in some cases. This consideration has led to the development of a magnetic drum system which reduces the number of components needed in a large system.

Magnetic Drum System

The magnetic drum is used as a storage device for all counting channels and for the data delays. The drum, *Fig.* 3, is approximately 8 inches in diameter and 2 inches in length; it is rotated at 1800 rpm. It is made of aluminum and has an iron oxide coating that serves as a memory. A block diagram of the data flow for a magnetic drum system is shown in *Fig.* 4.

The method whereby the drum is made to serve as a shift register is explained in the box entitled "Magnetic Drum For Data Delay."

When the drum is used in conjunction with an external counter it is possible to have the one counter perform the counting function for many different channels with the counting result stored on the drum surface. Thus for each tachometer impulse, the single high speed counter is switched completely through all counting channels. As it moves to a channel, the previous count is withdrawn from the drum surface by a reading head, and the counter is preset with this count. If the data from the shift register portion of the drum indicate a defect the preset count will be increased by one, the result being immediately restored on the magnetic drum. If a defect was not indicated the preset count is not changed and the same count is re-recorded on the

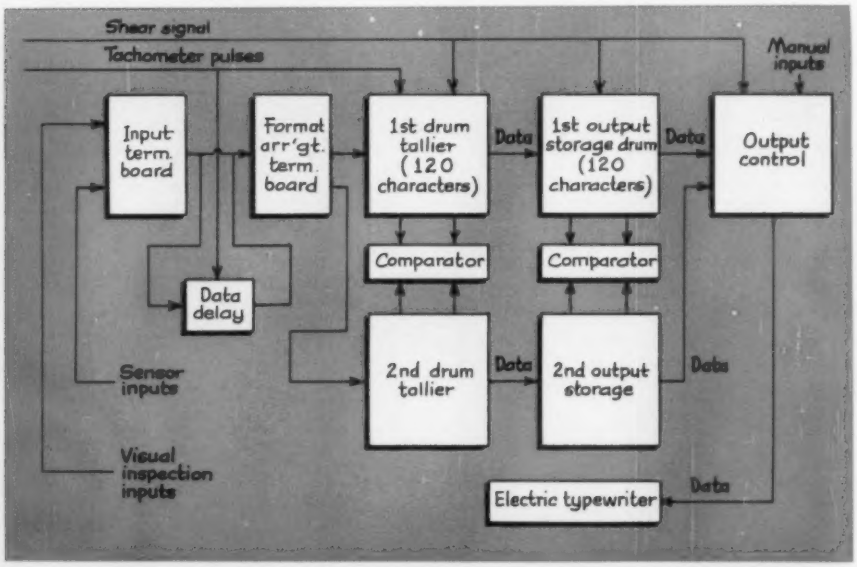


Fig. 4—Flow of data in logging system using a magnetic drum is shown. The element identified as data delay refers to the revolver system described in the box entitled "Magnetic Drum for Data Delay." In the interest of accuracy, the information on the counter and storage tracks is duplicated. A constant comparison of this duplicate information by the system insures that errors are immediately brought to operator's attention.

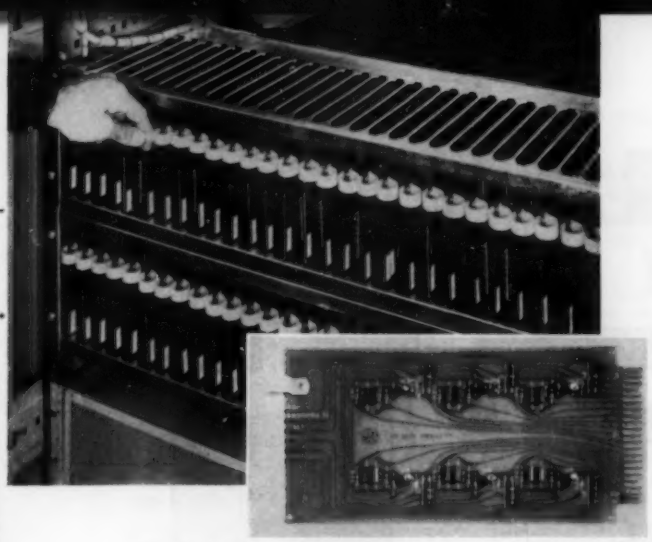


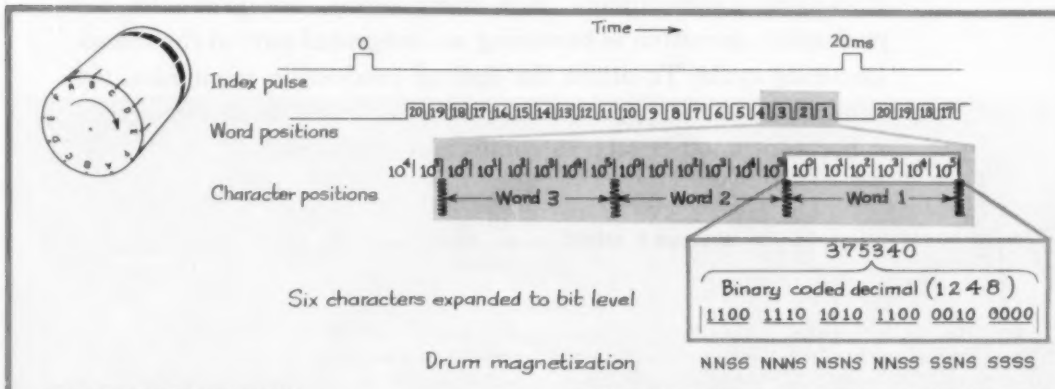
Fig. 5—Modular construction of the electronic gear is illustrated. The small boards are plugged into the chassis which contains necessary interwiring.

drum. The speed of the counter and the arrangement of reading and writing heads is such that the updating of the stored count is completed within one-half a drum revolution.

With the magnetic drum system it is possible to increase the system capacity with only a slight increase in cost. This feature makes it feasible to duplicate various channels in order to lessen the probability of errors. For example, the counting data are accumulated on dual data tracks. Similarly, data are stored on dual output storage tracks. The data on the dual tracks are constantly compared for accuracy and if the information is in agreement, the contents of only one storage track will be printed out at the shear signal. However, if there are discrepancies, indication will be made to the operator, and the contents of both tracks will be printed out.

Being able to store thousands of bits of information (see box entitled "Data Organization"), a drum can replace thousands of independent storage units, usually electronic or magnetic flip flops. This reduction in the number of components affects more than just the equipment cost, since the fewer the number of components the higher the degree of reliability. To simplify both construction and maintenance of the equipment, the electronic components in the data logging system are mounted on printed wiring plug-in boards, *Fig.* 5. The number of basic curcuit boards required is relatively low, the different functions being provided by suitably wiring the plug-in boards.

The plug-in boards are assembled in module racks that contain the wiring between boards. Reflecting the industrial locations where the data logging equipment is to be used, the modules are mounted in enclosing cabinets that have gasketed front doors and removable rear panels. To assure freedom from the dust and dirt as well as high ambient temperatures found in many locations, the cabinets are provided with a recirculating air conditioning system.



DATA ORGANIZATION

MAGNETIC DRUM of the size used in the data logging system could have as many as 32 tracks—a track being defined as the area of the drum which passes underneath a recording head. The diagram illustrates how data is organized on the drum. The two index pulses are recorded on the index track diametrically opposite each other. A data track contains 20 word positions between each of the index pulses. As used in a counting operation, the data from one inspection channel would be assigned to a particular word position.

As shown, a word position can record numerical information up to a count of 999,999 in the six character positions. The characters are written on the drum with the least significant character first, followed by next significant character, on up to the most significant character, i.e., 43,573 will appear as 375340.

The characters are actually written in a binary coded decimal form, in which 4 bits of information are used to define a decimal character. The binary code is represented on the drum by the polarity of four successive spots—a spot magnetized in the south direction representing a zero, a north representing a one. To sum up, a data track on the drum is divided into halves; each half can handle 20 channels, or word positions; a word consists of 6 digits; and each digit requires 4 bits of information. Thus, 480 bits are recorded per track on one half of the drum.

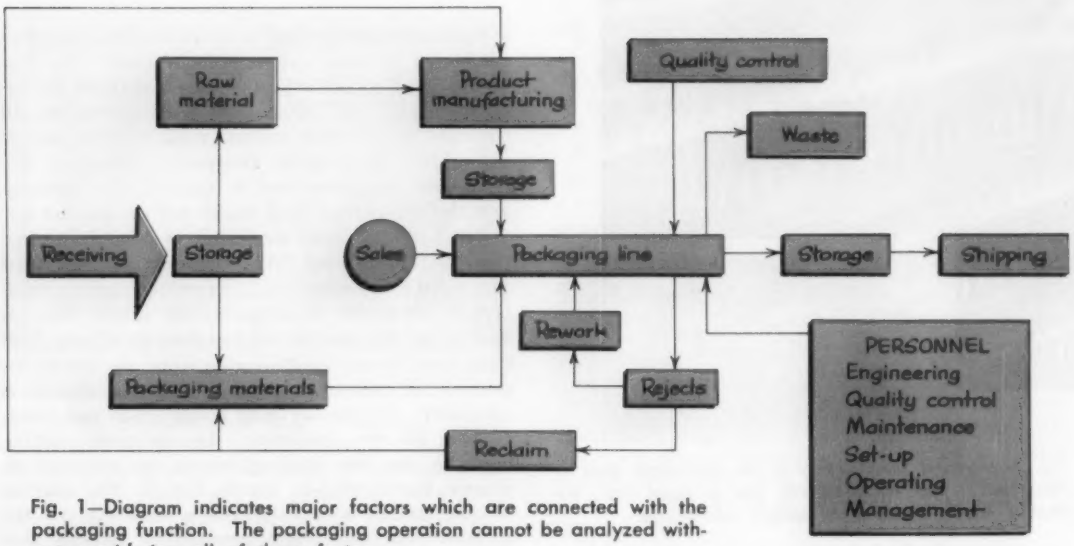


Fig. 1—Diagram indicates major factors which are connected with the packaging function. The packaging operation cannot be analyzed without considering all of these factors.

INTEGRATING THE PACKAGING OPERATION

Packaging requirements take many forms, but gradually the packaging operation is becoming an integrated part of the manufacturing cycle. To attain the desired production economies, the departmentalized approach to packaging must be abandoned as it becomes another step in continuous production.

By **WILLIAM E. WOOD,** President, Processes Research Inc., Cincinnati, Ohio

IN TODAY'S highly competitive domestic and foreign markets, it is becoming increasingly important to consider all facets in the production of goods, from receiving of materials to shipping of finished products, in an effort to reduce unit costs. And packaging is one of the important functions where economies can be realized. Modern concepts point to two areas where improvements in packaging can be obtained: The application of automatic techniques to packaging equipment and the integration of the packaging line into plant operations. The results of these improvements include reduction in both processing time and labor requirements—indeed, the latter has sometimes been reduced in a startling fashion.

Automation or mechanization often has been accepted on only one basis—labor savings through increased productivity per man. Yet it has been demonstrated that by the careful application of mechanization, additional gains can be realized which are often of greater benefit than labor savings. Some of these benefits are: Improved quality; reduction in packaging lead time on rush shipments; reduction in scrap losses; reduction in labor turnover through better working conditions; utilization of less-skilled labor; and reduction in the factory size, resulting in lower building costs. Obviously all of these gains are not realized in every application, but they are worth evaluating for each process involved.

Integration of the packaging line into the plant

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

operation also has some disadvantages. These are as follows:

1. Reduction in flexibility as to products manufactured. Careful market analysis and forecasting will help to minimize this disadvantage. The flexibility to handle all anticipated changes in product design and packaging must be the guiding consideration in the design of the system.

2. Reduction in input flexibility to the packaging line. The input acceptable to a mechanized package line is almost as inflexible as the output. Packaging material changes in labels, cartons, product, product containers, etc., affect the ability of the system to operate acceptably. This can be minimized by careful design and planning, and possibly by the use of portable machinery.

3. Reduction as to flexibility of scheduling. Change-over time for a product line in the case of complicated systems may require maintaining larger inventories of packaged goods than ordinarily deemed necessary.

4. The need for fast reaction time. Although mechanization enables the plant to produce products in large quantities, each minute of downtime represents a correspondingly longer interruption in the delivery of finished goods to the warehouse. Therefore, planning and scheduling of products and machines must be carefully integrated, and downtime must be held to an absolute minimum. Control and planning of preventive maintenance is also vital. Equally important is continuous inspection, adequate storage areas for rejects, and rapid response to the correction of malfunctions and the arrangements for feedback of corrected or adjusted rejects.

Integration of the packaging line into the plant operations requires careful mechanization of the feeds to the line and the removal of work from the line. The mechanization of the input feeds and work removal from the line has the effect of increasing equipment utilization. In a certain plant it has been found that equipment utilization was increased from 60 to 80 per cent (an increase of 33 per cent) by the mechanization of input and removal of work from the line.

Automatic application of the packaging materials, automatic fastening (gluing, binding, stapling, etc.), automatic marking (identification, shipping labels), and automatic dispatching to shipping are advantages to be gained by mechanization. The benefits that accrue—reduction in labor, uniformity of packaging, faster handling of the product, improved quality, and a reduction in damaged goods—generally far outweigh the attendant disadvantages. By proper integration and design the disadvantages are minimized.

Fig. 1 depicts the various factors which have to be considered when integrating the packaging line into plant operations. The packaging line is depicted as the central theme in plant operations in order to focus attention on all factors which affect the line. How does each factor affect the design of the packaging line?

▸ Management and Sales

Before it is possible to ascertain the degree with which the packaging line should be integrated into the plant operations, it is necessary to obtain data from management and sales as to their forecast of requirements for the individual products. The first requirement is a projected three to five year forecast of sales for each product, in an effort to determine the daily rates of each product and the total number of different items to be produced. For example, this forecast should answer the following questions: Which items are growth items? Which items in all probability will be dropped or changed? Which items

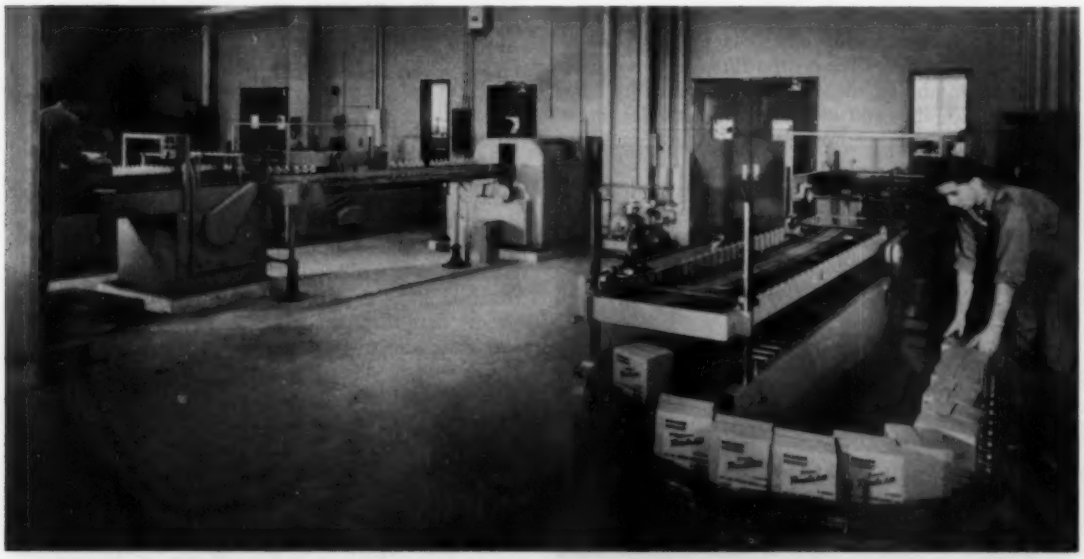


Fig. 2—Partition, in background, separates packaging and warehousing areas. In the warehousing area, shown, bottles to be filled are placed on a conveyor leading to the packaging area. Filled cartons containing finished packaged products are removed from the conveyor coming from the packaging area.

Fig. 3—Packaging area is located on opposite side of partition shown in *Fig.* 2. As indicated, this partitioned arrangement enables the actual packaging area to be as clean and as attractive as is desired.

will be modified due to the changing market conditions? What are the prospects for the addition of new items?

Once these questions have been answered and management has indicated the number of hours or shifts the plant is to operate per day, it becomes possible to determine the estimated packaging line utilization.

Management must set forth clear definitions of the responsibility of the various departments with regard to the packaging line. Fields of endeavor, such as production, engineering, package design, delivery of the packaging materials to the point of use, maintenance services on the line, setup services, waste accountability, disposal of rejects, quality control, housekeeping, and other related activities, must be adequately defined and personnel designated to handle them.

To facilitate this designation of responsibilities, it is imperative that the responsible parties in production, engineering, quality control, and package design meet together and evolve an arrangement which integrates the activities of each section into the whole program.

▸ Manufacturing

The manufacturing operation influences the packaging line with relationship to the flow of materials from the production area to the packaging line. If the product is made by a batch process, a sufficient storage area must be provided for backup of the packaging line so as to permit the line to operate without delays due to supply of the product to the point of application. If manufacturing is a continuous operation, then balancing of the output of each operation must be carefully integrated. Depending on the product manufactured, extremes are encountered which provide a tremendous range in the integration process. These involve from a three to six months aging prior to packaging of the product manufactured to an instantaneous filling and packaging operation after production.

Generally, it is improbable, due to marketing changes, that each packaging line will be operated continuously year-in and year-out using the same product or packaging technique. This means that ease of change-over from one product or packaging technique to another is imperative. The more often change-overs are required, the less automated a packaging line can become. By analysis, this problem can be greatly reduced by careful classification of the types of packaging operations required for the particular plant in question. Often the different setups for a particular packaging line can be reduced to, say, four or five variations. By the proper design or selection of packaging equipment, it is possible to insert in the line that machine which is required for the particular setup in question. This means that these machines must be portable and of the exact size to fit into the space required. Careful planning and design ahead of time will insure ease of change with minimum downtime. Planning and scheduling becomes a crucial operation between the manufacturing, engineering, and packaging groups; and the success of the packaging line hinges on the ability of these groups to work together harmoniously.

In some operations, packaging of materials includes the actual filling of tubes, bottles, etc., and in many cases requires that the change-over from one product to another involves cleaning out of all lines and changing of packaging materials. The

design of such an installation is of prime importance, so that cleaning out can be handled with dispatch and changing of packaging materials can be completed with a minimum of lost time and motion.

Package Design

Generally speaking, the more highly automated the packaging line becomes, the more difficult and expensive it is to accommodate package and style changes. The problem is to provide sufficient flexibility in automated machinery to accommodate changes. The personnel responsible for package design must be consulted before equipment is purchased to determine possible trends in package design over the 3 to 5 year span. In many cases, compromises can be effected which will permit the use of a particular piece of equipment for its entire life with very minor modifications. Sometimes this involves a good bit of "blue sky" planning to realize these benefits. The full range of package designs should be explored prior to setting up of the packaging line itself. Many factors are affected by the size of the package required. Package design and future anticipated changes will materially affect the special requirements, conveyor sizes, power requirements, machinery cost, etc. The extent to which "reshippers" will be used in relationship to new materials should also be known in order to provide for adequate handling facilities.

Quality Control

Ultimately, package quality must reflect the equipment and methods used. Therefore, before quality standards can be established, it is necessary that the desired quality be factored into the actual design of the equipment and methods used. For example, if vibration of a conveyor belt in a particular application produces ripples on the surface of a solidifying material in its ultimate package, then quality control cannot expect to attain a smooth flat surface of the final material because it is beyond the capability of the machine to produce it. It is necessary for quality control to specify exactly what is required in the way of a quality finished product so that the machine and equipment can be designed to produce the product. Sometimes it becomes necessary, because of equipment limitations, to compromise on quality to a certain extent. Generally, however, once the quality has been established, machinery and equipment can be designed to accommodate such specifications.

Under the general heading of quality control, consideration must also be given to the method to be used for inspection. This will include the handling of rejects, the reworking of the individual items, and the ultimate repositioning on the packaging line. In the layout of the line it is often possible to install a rework loop which permits rejects to be accumulated, and then reworked preparatory to repositioning on the packaging line. By the proper allowance of a work area for these rejects, the flow of material is not affected, and the line production rate is maintained. For those rejects that cannot be reworked, it becomes necessary to provide for handling and classification either as waste or as reclaimable, in part or in whole. These operations, by their very nature, should be handled away from the packaging line proper in order not to clutter up and confuse the packaging areas.

Storage and Housekeeping

Two of the very vital adjuncts of a successful integrated packaging line are the availability of the storage facilities and the degree with which housekeeping is maintained. Proximity of the storage materials at the point of use is desirable. The quality of the finished product, production rate, the ease of change-over, and the dispatch with which the productivity is maintained are a direct function of the convenience of the storage materials at the point-of-use and the housekeeping around the packaging line. It can be difficult to maintain good housekeeping when many packaging materials are required. Considering boxes, separators, labels, wrappers, containers, etc., along with rejects and rework items, housekeeping and general storage can become over-burdening unless provisions have been built into the actual plant layout. The type and amount of space required for the storage of materials will depend upon the quantity and frequency of use, as well as dependability of supply.

One way to improve on the storage and housekeeping problems is to utilize U-shaped packaging

Fig. 4—In order picking area, various numbers of cartons from each line are combined in meeting shipping requirements. Extensive use of gravity conveyor racks in an automatic system is illustrated.

Fig. 5—Conveyor storage system, illustrated in *Fig.* 4, is controlled from this panel. Operator indicates desired quantities of each product, which are then automatically released by the several storage conveyor lines affected.

lines as indicated by *Fig.* 2 and 3. In this operation, materials handling, both the supplying of bottles to the packaging line and the product warehousing, is handled on one side of a partition separating the warehousing area from the packaging area, *Fig.* 2. Only those materials actually used during packaging are allowed in the packaging area, *Fig.* 3. This has the effect of keeping the natural requirements of cardboard boxes and similar packaging materials out of the main packaging area itself. This technique, of course, cannot be used in many instances, but by proper study of detailed flow diagrams, it is possible to design a packaging line which will take into account and prepare for the required materials.

Packaging Line Environment

The following considerations must be evaluated when considering the environment in which the packaging line is installed:

1. Air Conditioning. It must be ascertained if humidity affects the product and if it is necessary to remove excessive heat produced by equipment, such as ovens, required for the packaging operation. There is also the problem of cleanliness (dust-free atmosphere, sterile atmosphere, etc.). Employee comfort should also be considered.

2. Lighting. The degree of illumination required in foot candles at the work surface must be established, and areas requiring special lighting, such as for inspection, must be known.

3. Ease of cleaning. It is necessary that the packaging line be so designed and laid out that quick and easy cleaning is possible without disruption of the packaging operation.

4. Proximity to facilities. Typical items include: Washrooms, cafeteria, rest areas, maintenance shops, and support areas such as quality control, engineering, production, etc.

5. Pleasant surroundings. Attention to the attractiveness of the surroundings is important to employee morale. Attractive surroundings are also conducive to good housekeeping and pride of workmanship.

Packaging Machinery

The proper design of the packaging machinery, and the degree of automation of the packaging line, will depend upon an economic analysis. The higher the rate of production, and the longer the anticipated run of production, the more automated the packaging line can become. Often the use of automated portable machinery will permit a maximum of automation for a product line which is subject to changes of production at periodic intervals. The portable machinery can be moved from package line to package line to fulfill the requirements of the particular line involved. In places where it is not advantageous to use portable machinery, the selection of machinery with built-in flexibility and capability for modification is desirable. In this manner, adjustments can be made to compensate for minor changes in packaging requirements. This revamping of packaging machinery should be easy to accomplish, otherwise downtime for the line in question will be high.

For a packaging line which is expected to run for an extended period of time, the application of specialized automated machinery becomes practical. There are several manufacturers in the United States who are capable of designing automated machinery to suit practically all packaging requirements. In specialized machinery it becomes practical to combine several packaging operations within the single machine and thus conserve space. If the economics of the packaging line can justify such

a machine, then it becomes advisable to employ packaging materials which come in continuous strips and are cut off by the machine itself, rather than to use materials which are supplied for each individual package separately. By using this technique, it is possible to reduce the materials handling problem associated with all packaging machines.

A most important aspect of an automated packaging line is to design each machine used in the line to accept the same rate of production. Often there is one machine in the line which produces a "bottleneck" in the system. Generally, this condition is not apparent at first, but comes as a result of continuous pressure over the course of several years to speed up production in an effort to reduce unit costs. If the machine cannot be adjusted to accept the higher production rate, then it becomes necessary to provide two machines in parallel at the bottleneck. This not only increases the floor space requirements, but complicates the flow of material to and from this area.

Control Systems

A carefully designed control system is of primary importance in the successful integration of the packaging line into the plant operation. There are several aspects to the control system which must be considered. Machine speeds must be synchronized for all units in the packaging line to insure that the material flow will not back up at any one point. This can be accomplished in several ways, one of which is to use line shafting with power take-offs at the desired points. Equipment can be provided with automatic features, such as the use of photoelectric actuated devices for removal of rejects and probes to sense gaps in the flow of material to the machine. These probes will signal the machine to skip one or more operations, depending on the number of spaces between items to be packaged. Adequate controls should be provided for removing rejects and accepting reworked materials.

Machines should include safeguards such as shear pins, torque limiters, etc., to limit the damage caused by malfunctions. Automatic lubrication systems should be installed to prevent excessive wear at bearing points on the machine.

Care must be exercised to keep the control systems simple, in order to reduce maintenance and probability of malfunction. With a highly-automated line, controls are vital to satisfactory operation, since they can sense trouble long before an operator could push the proper button to stop the sequence of operation. If the controls are kept simple, experience has shown that supervision of the machine is reduced.

Shipping

The final aspect of a successfully automated and integrated packaging line operation is an automatic order picking system for the loading of the packaged goods into transportation vehicles. *Fig.* 4 and 5 depict a highly-automated order picking system for the Lambert-Hudnut Mfg. Laboratories Inc., Lititz, Pa. This system, *Fig.* 4, is capable of selecting any one of 20 different products and delivering the proper number of that particular product, along with a chosen number of any other of the 19 products directly to the truck platform without further materials handling by plant personnel. The employee shown at the operating console, *Fig.* 5, has just selected from his order sheet the number of cartons of each type of material ordered; he has entered these quantities on the control console preparatory to pushing the start button which will automatically feed the proper number of cartons of each product to the truck without further attention. The only other personnel requirements for this order picking system are two employees who keep the gravity conveyors filled with the particular carton that each is to handle.

The average time to complete a truck shipment and completely pack the trailer varies from three-quarters of an hour to one and one-half hours, depending on the size and weight of each carton. Adoption of this system has markedly reduced the manpower requirements in the shipping area. The economical use of such a system is relegated to the shipment of high volume items only. A movement of low volume cartons cannot be justified due to the expense of the installation.

Packaging Line Layout

A properly designed packaging line layout is essential to the efficient operation, and all other plant operations must be grouped so as not to favor one operation over another. The information highlighted in ths article must be carefully considered for plant layout.

Integrating the packaging line into the manufacturing process presents problems which are peculiar to each plant. The success of the installation will depend to a large degree upon the amount of valid information which the designers possess when the plans are prepared prior to construction. It is extremely vital that all parties concerned adequately appraise their situation and affiliation with the packaging line in order to provide the information necessary.

As the packaging line becomes more automated, the capital cost of the equipment involved becomes appreciable. Therefore, it is necessary that the correct information be obtained prior to making any commitments. One point deserves reiteration: It is essential to bear in mind that each plant has problems which are unique to its own operation, and therefore requires special attention to details in order to obtain a successful operation. This is really the key to any successful integration of packaging to the plant operations; namely, attention to detail.

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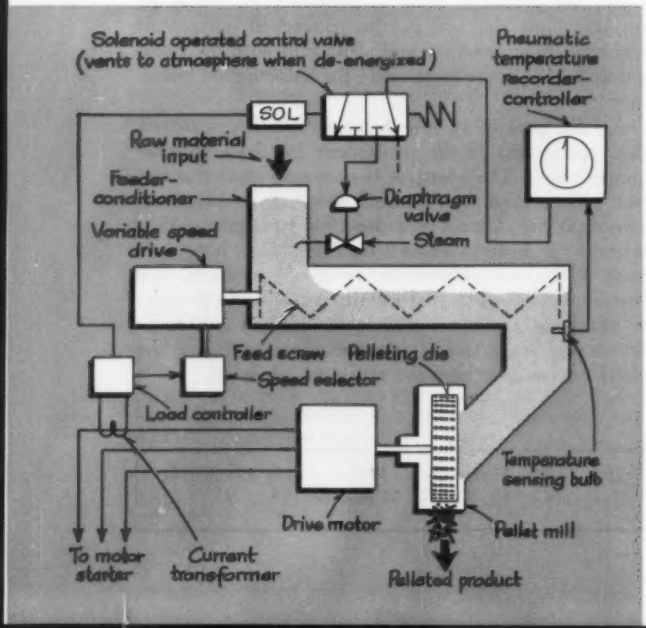
Fig. 1—Electrical and pneumatic controls for two pellet mills, left, are centralized in floor enclosure, right. The controls regulate the load on the pellet mill drive motors and maintain optimum material temperatures for maximum pellet quality and yield.

- MOTOR LOAD
- FLOW RATE
- TEMPERATURE

CONTROLLED FOR

AUTOMATIC FEED PELLETING

Some of the control schemes that can be formed from available electrical, pneumatic, and electropneumatic components are illustrated in this description of two automated pellet mill installations. Variables that are controlled automatically include solid and liquid feed rates, temperature, and motor load. Interlocks ensure safety of operations and proper processing sequence at all times.



AUTOMATIC control schemes recently adopted by McMillen Feed Mills, Div., Central Soya Co., have resulted in improved safety of operations and increased output for two types of feed pelleting processes. In one application, electrical and pneumatic controls permit a pelleting mill to operate at peak horsepower and maintain optimum mash temperatures without danger of plugging. In the second application, a more elaborate electropneumatic control system provides the additional ability to automatically add liquids to the mash in predetermined ratio to the dry weight of the material being fed. The control systems were

Fig. 2—Simplified diagram illustrates major machine and control elements used in pellet mill installation of *Fig.* 1. Load on pellet mill drive motor is controlled by varying speed of feed screw delivering material to the mill.

developed by engineers of Sprout, Waldron & Co. Inc., and are used with 100-horsepower pellet mills manufactured by that company.

Electrical and Pneumatic Controls

Two pellet mills have been equipped with electrical and pneumatic controls at the Camp Hill, Pa., plant of McMillen Feed Mills, *Fig.* 1. The controls permit automatic operation of the mills without the need for constant operator attention. According to McMillen personnel, it is possible for one operator to attend as many as ten such mills under optimum conditions.

A block diagram of the system, *Fig.* 2, indicates the functions performed by the controls. One of these functions involves adjusting the speed of the mash feed screw so as to maintain a preset load on the drive motor for the pellet mill. This is accomplished by an electrical circuit that includes a current transformer, a load controller, and a speed selector, *Fig.* 2.

The current transformer senses the electrical current in one power lead of the pellet mill drive motor. Output of the current transformer is fed to the load controller, where it acts upon a series of relays that provide three types of control actions:

1. If the load on the drive motor should drop below a preset value, indicating an empty mash bin or formation of a material bridge, a low load limit relay in the load controller will drop out. This will energize the speed selector and adjust a variable speed drive for minimum feed screw speed. Additional contacts on the low load limit relay will de-energize the solenoid of a control valve, and the steam supply to the pellet mill will be shut off. When the condition causing a material shortage has been corrected, the low load limit relay is automatically energized by an increase in the load, and the feed screw speed and steam flow rate are restored to automatic control.

2. A high load limit relay in the load controller is set to trip at 150 to 175 per cent of full-load drive motor current. When this relay trips, the pellet mill is about to plug. To give the mill an opportunity to clear itself of the overload, the feed screw is stopped and the steam flow is cut off by the high load limit relay. Usually, the pellet mill clears itself and runs empty until an operator again starts

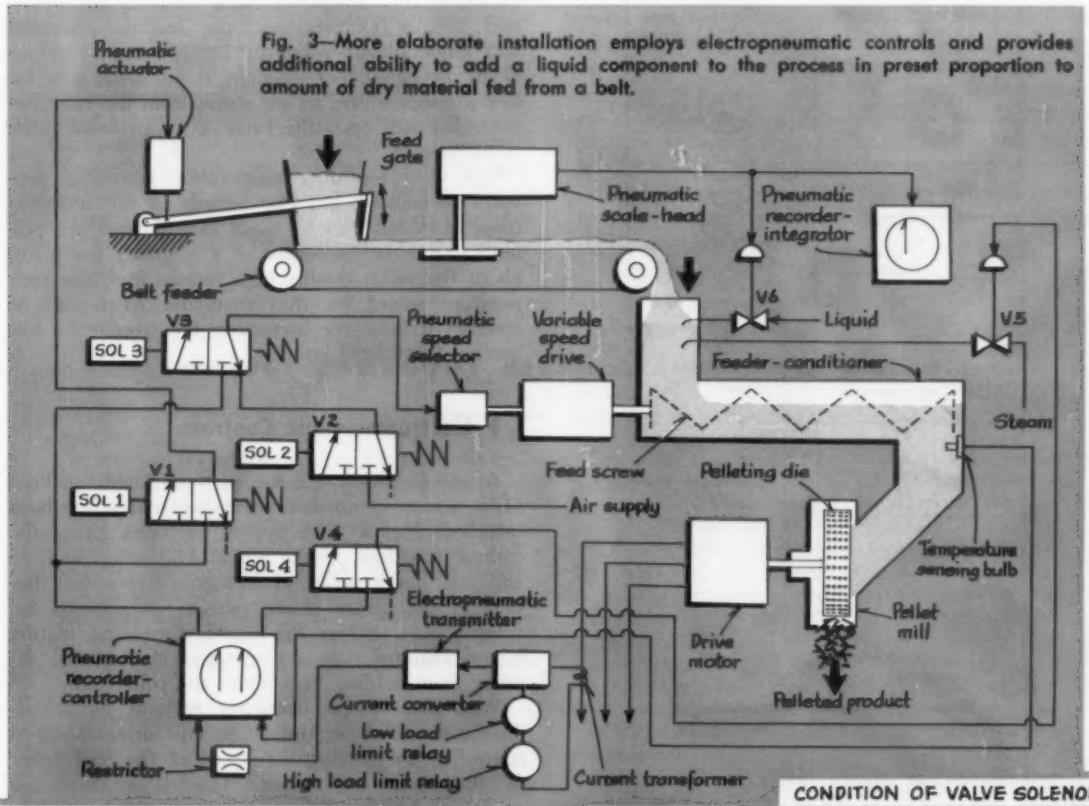


Fig. 3—More elaborate installation employs electropneumatic controls and provides additional ability to add a liquid component to the process in preset proportion to amount of dry material fed from a belt.

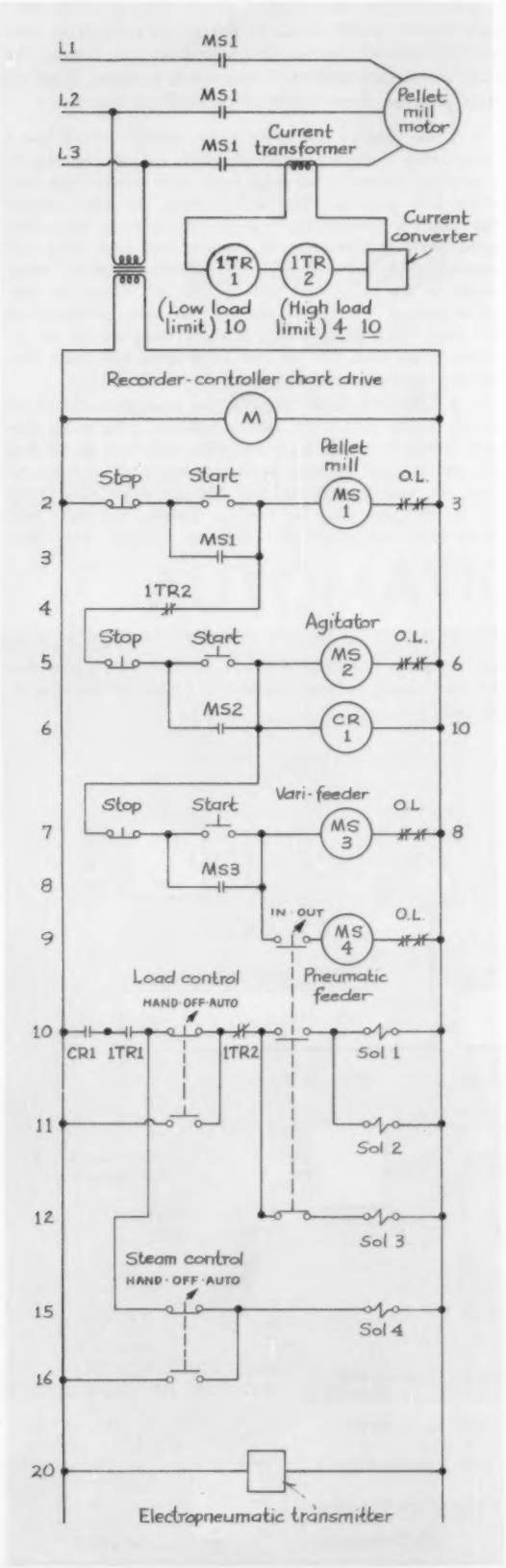
KEY TO VALVES

V1·V2·V3·V4 - Solenoid operated 3-way, two position, directional control valves.

V5 - Pneumatically operated steam valve.

V6 - Pneumatically operated liquid control valve.

	CONDITION OF VALVE SOLENOID			
Type of Operation	SOL 1	SOL 2	SOL 3	SOL 4
With liquid addition	+	+	—	+
Without liquid addition	—	—	+	+
+ - Energized	— - De-energized			



the feed screw motor. This action also energizes the solenoid of the steam control valve, and steam is again admitted to the process.

3. A third relay in the load controller decides when the feed screw speed should be increased or decreased to maintain a preset load on the pellet mill drive motor under normal conditions. Typically, this relay might be set to maintain motor loads between 96 and 100 per cent of full load. High and low load limit contacts on the relay—working in conjunction with auxiliary control and time delay relays—operate the speed control motor when an adjustment of the feed screw speed is needed to maintain optimum loading of the drive motor.

A second function performed by the control system, *Fig.* 2, is that of regulating the flow of steam to the process in order to maintain the temperature of the mash within preset limits. Control of mash temperature is necessary in order to ensure the production of high quality pellets at a maximum rate for the horsepower available. In this instance, pneumatic instruments and controls are used.

A temperature bulb placed in the mash stream ahead of the pelleting die senses actual mash temperature. A pneumatic recorder-controller receives signals from the bulb and compares them with a preset signal representing the desired mash temperature. If a difference exists between the actual and desired temperatures, the recorder-controller will automatically reset the steam valve by means of an air signal. For example, if the mash is at too low a temperature, an air signal from the recorder-controller will open the valve to admit more steam to the process.

Use of a recording temperature controller provides permanent, 24-hour records of the temperatures at which various mash formulations are pelleted. Thus, in the event of a customer complaint about the pellet quality of a certain feed, the temperature record for that particular batch can be used as a basis for correcting the trouble in like batches formulated later.

Electropneumatic Controls

At the Des Moines, Iowa, plant of McMillen Feed Mills, a more comprehensive control system has been installed, *Fig.* 3. This system performs all of the control functions of the Camp Hill setup and, in addition, has a provision for optionally adding liquids in percentage of dry weight of material fed from a belt. When the liquid dispensing feature is not required, the dry material may be fed directly from holding bins above the pellet mill.

With the system operating without liquid addition, the load on the pellet mill drive motor is controlled by varying the speed of the feed screw in the feeder-conditioner. This is accomplished

Fig. 4—Elementary diagram of electrical controls for system of *Fig.* 3 illustrates interlocking of control components to provide safe operations in preset sequence.

through operation of a pneumatic speed selector mounted on the variable speed drive for the feed screw, *Fig.* 3.

In this type of operation, the speed selector receives controlled air signals from a pneumatic recorder-controller through solenoid operated valve *V*3. The control signals from the pneumatic instrument are derived by continuously comparing a preset pressure (representing a full-load drive motor condition) with an air pressure signal from an electropneumatic transmitter (reflecting the actual drive motor load condition). When the two pressures are unequal, the control signal from the instrument to the speed selector will cause an appropriate adjustment of the feed screw speed. Proportional and rate controls within the pneumatic recorder-controller determine the rate at which load correction takes place.

When it is desired to add a liquid to the process, the load on the pellet mill is controlled by varying the position of the feed gate for a belt feeder, *Fig.* 3. In this case, *SOL* 3 is de-energized and *SOL* 1 and *SOL* 2 are energized. Operation of valve *V*1 by *SOL* 1 admits control signals from the pneumatic recorder-controller to a pneumatic actuator. The actuator varies the position of the feed gate as required to maintain a constant pellet mill motor load. Operation of valve *V*2 by *SOL* 2 admits a fixed air pressure to the pneumatic speed selector, and the variable speed drive for the feed screw operates at a constant, high speed.

To control liquid flow, a pneumatic scale head continuously weighs the material passing a sensing device on the belt. Air signals from the scale head operate a liquid control valve, *V*6, admitting liquid to the process in preset proportion to the weight of material passing the sensing device. In this manner, a constant percentage of liquid to solid material is maintained even during fluctuations in solid material flow due to load variations. A pneumatic recorder-integrator indicates material flow rates.

Temperature control is accomplished in the same manner as in the example described previously. In this case, a dual recorder-controller is used so that pneumatic load and temperature control can be centralized in one instrument. Separate setting knobs and manual regulators are provided for each function.

Interlocked Operations

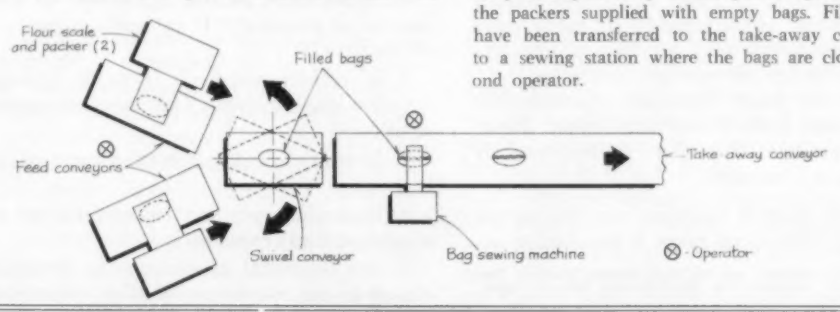
Electrical, pneumatic, and electropneumatic control schemes have been described for the automatic control of solid and liquid feed rates, temperature, and motor load. Supplementing these controls in the actual equipment are standard electrical components—pushbuttons, relays, and limit switches—that are interlocked so that the systems can be operated only in the proper sequence. In the Des Moines setup, for example, the pellet mill drive motor and a constant speed agitator motor must be operated before the variable speed feed screw motor can be started. When these units are operating, the pneumatic scale unit may be activated to control the feeding of a liquid component. The pellet mill drive motor must be loaded above the preset low load limit before steam can be admitted to the process. These relationships may be followed by referring to the elementary diagram for the electrical controls, *Fig.* 4.

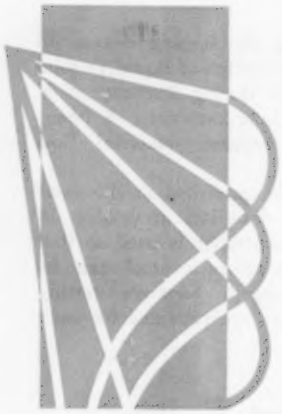
swivel conveyor merges two flow paths

SPECIAL arrangement of machines and conveyors has simplified handling and increased output for a flour bagging and bag sewing line built by Richardson Scale Co. With the system, two men can fill and sew up to sixteen 100-pound bags per minute.

The layout includes a short, swivel conveyor section placed at the Y-junction of two feed conveyors and a take-away conveyor (see diagram). The swivel conveyor section may adopt any of three positions: 1. In line with one of the feed conveyors. 2. In line with the other feed conveyor. 3. In line with the take-away conveyor. Purpose of the swivel section is to provide a means for automatically channeling filled bags from either feed conveyor to the take-away conveyor.

Equipment used in the line includes two flour scales and packers positioned over the feed conveyors, and a sewing machine located at a station along the take-away conveyor. In operation, one man stationed between the feed conveyors operates the two packers. When a bag has been filled with a predetermined weight of flour by a packer, it automatically drops onto the associated feed conveyor. The filled bag may then be transferred to the swivel conveyor section for routing to the take-away conveyor. Duty of the packer operator is to keep the packers supplied with empty bags. Filled bags that have been transferred to the take-away conveyor move to a sewing station where the bags are closed by a second operator.





APPLYING ADJUSTABLE-SPEED DRIVES

Increasing complexity of modern manufacturing technology calls for more frequent application of adjustable-speed drives. Selection of the most economical drive for a particular machine or process requires careful consideration. Major factors involved in making such a selection are discussed by the author.

By **E. C. WATSON,** DC Motor Engineering, Motor Dept., Westinghouse Electric Corp., Buffalo, N. Y.

TODAY'S demands for more automatic processes, closer quality control, and maximum production often lead to a requirement for some type of adjustable-speed drive. However, the number of different drives available can create a problem of selecting the one best suited to the needs of the application.

There is no magic formula for selecting adjustable-speed drives. The choice is simply a matter of service and economy. In the final analysis, the decision is based on factors unique to each application. A few guidelines can be provided, however, as an aid in the proper selection from among several common types of adjustable-speed drives. In most cases the pertinent engineering factors will limit the choice to a few types, from which a final selection may be made using economic factors.

Drive Selection Factors

The first step in selecting a unit is to determine all of the drive requirements. These requirements may be broken down into two categories—specific needs and desirable characteristics. In many cases a desirable characteristic may not be a prerequisite when economic factors are carefully evaluated.

In TABLE 1 are shown important characteristics of several common types of adjustable-speed drives. Typical drive questions that might be answered by reference to TABLE 1 include:

1. What speed range is necessary over the normal operating range? The speed range is matched to actual drive requirements. Consider the possibility of using a limited operating speed range. Often, such a drive will be a more economical selection.

2. Is a low, preset speed desired for jogging or creeping? Is creeping speed to be used for machine setup?

3. What is the torque requirement? Is the drive constant torque, constant horsepower, or a combination? Care is needed in selecting torque requirements. Many drives provide constant torque, and, unless the load requirements match this, an excess capacity must be provided to supply the needs of the most severe operating condition. It is best to select a drive that will most nearly match the load characteristics.

4. What type of enclosure is needed for the rotating member (motor), and for the control? Most machine tool applications require some type of enclosure or protection. Not all available drives can be fully enclosed. An enclosure with no greater protection than required leads to the most economical choice.

5. What speed control signal will be available—manual or automatic? If automatic, what is the form of the signal?

6. Is braking required? If so, is it regenerative (overhauling), dynamic (soft stop), or external (mechanical)?

7. Is multiple motor operation required for tracking?

8. Is parallel operation (more than one motor on a common load) required?

9. Are controlled acceleration or deceleration included in the requirements? If so, what rate of ac-

Based on a paper presented at the 24th Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corp., Pittsburgh, April 1960.

TABLE 1—Characteristics of Common Types of Adjustable-Speed Drives

	Multispeed ac Motor	Wound Rotor ac Motor	Modified Kraemer Drive	Constant Voltage dc Motor	Adjustable Voltage dc drive		Electromagnetic Drive
					M-g Set Power Supply	Static Power Supply	
Normal Speed Range	Maximum of 4 discrete speeds	2 to 1	3 to 1	4 to 1	8 to 1[1] or 4 to 1[2]	8 to 1[1] or 4 to 1[2]	34 to 1 (2 pole) 17 to 1 (4 pole)
Low Speed for Jogging	No	Yes	Yes	No[3]	Yes	Yes	Yes
Torque Availability	Constant torque	Constant torque	Constant torque or horsepower	Constant horsepower	Constant torque or horsepower	Constant torque or horsepower	Constant torque
Enclosure Availability	All	All	All	All	All	All	Open[4]
Speed Control Means	Steps using line starter	Steps using power contactors	Rheostat or potentiometer	Field rheostat	Rheostat or potentiometer	Rheostat or potentiometer	Rheostat or potentiometer
Speed Regulation	5 per cent	Poor	5 to 7½ per cent	10 to 15 per cent	±5 per cent with regulator	±5 per cent with regulator	±2 per cent with regulator
Braking							
a) Regenerative	Yes	Yes	No	No	Yes	No	No
b) Dynamic	Yes	Yes	Yes	Yes	Yes	Yes	No
c) External	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiple Motor Operation	Yes	Yes	No	Yes	Yes	Yes	No
Parallel Motor Operation	Yes	No	Yes	Yes	Yes	Yes	Yes
Controlled Acceleration & Deceleration	No	No	No	Yes	Yes	Acceleration only	Yes
Horsepower Ratings	1-500	1-500	7½-500	1-500	1-500	1-200	¼ and up
Efficiency at							
a) Top Speed	85-90%	80-85%	80-85%	80-85%	63-73%	70-80%	80-85%
b) Full Torque	83-85%	29%	73-78%	83-87%	60-67%	60-70%	29%
Power Units	ac motor	ac motor	ac motor, dc motor, and rectifier	Rectifier and dc motor	ac motor, dc generator, and dc motor	Reactor, rectifier, and dc motor	ac motor and electromagnetic coupling
Rotor Inertia[5]	60%	90%	175%	100%[6]	100%	100%	75%
Number of Commutators or Slip Ring Assemblies	None	1 slip ring assembly	1 commutator 1 slip ring assembly	1 commutator	2 commutators	1 commutator	None
Starting Torque[7]	200-300%	200%	200-300%	200-300%	200-300%	200-300%	200-300%

[1]Constant torque operation.
[2]Constant horsepower operation.
[3]Low speed operation can be obtained by means of armature resistance.
[4]Totally enclosed units must be water or oil cooled.
[5]Standard dc motor equals 100 per cent.
[6]Normally a larger dc motor is used for slower base speed.
[7]Per cent of rated full-load torque.

celeration and/or deceleration is needed? Is the rate to be time or torque controlled? The need for controlling the rate of acceleration or deceleration is for the protection of the driven equipment or the drive. For the protection of the motor, the machine tool design engineer can provide equipment best suited for the drive chosen. Specifications for a particular application should list only the requirements for protecting the machine tool if the most economical solution is desired.

10. Is a speed regulator needed for close regulation? Speed regulators holding very close speed control are available for all drives except ac multiple speed motors. Specification of regulators for closer regulations than those listed in TABLE 1 will add to the initial cost, and the requirement for better regulation must be fully evaluated.

11. What problems of maintenance should be considered in selecting a drive? The cost of maintenance and operation should always be considered. However, the determining factors are not easy to evaluate. Cost of power, which is reflected in the efficiency

of the drive, is not always easy to determine but should not be overlooked. Cost of maintenance must include consideration of number and kind of wearing parts such as brushes, relays, bearings, etc. These factors are not always determinable by the machine tool builder, but they can and should be considered in comparing various adjustable-speed drives.

Common Types of Drives

All adjustable-speed drives discussed are predicated on the availability of ac power. In addition, the term "drive" includes the necessary conversion equipment to produce adjustable speed. The most common adjustable-speed drives are: 1. Multispeed ac motor. 2. Wound rotor ac motor. 3. Modified Kraemer drive. 4. Constant voltage dc motor. 5. Adjustable voltage dc drive with motor-generator set. 6. Adjustable voltage dc drive with static power supply. 7. Electromagnetic drive.

Multispeed ac Motor. Strictly speaking, this is not an adjustable-speed drive—it is an ac motor with a fixed number (usually two or four) of speeds. No adjustment is available between steps. If discrete speeds, not exceeding four, can satisfy the requirements of the drive, then the multispeed ac motor is usually the best economic choice. This drive is usually not sufficient for precise machine tools requiring adjustable speed. It uses a standard motor construction with multiple windings to secure the speed combination required. Typical speed-torque relationships are shown in *Fig.* 1.

Wound Rotor ac Motor. Speed control of a wound rotor motor is obtained by varying the resistance in series with the secondary winding. Theoretically, the available speed range is large. However, regulation is relatively poor since, under light load conditions, the motor approaches synchronous speed. From a practical standpoint, therefore, the drive is limited to a 2:1 speed range. Efficiency drops as speed decreases since relatively large amounts of power are dissipated in the secondary resistances. In *Fig.* 2 are shown typical speed-torque characteristics of wound rotor motors with different amounts of resistance in their secondary circuits.

Modified Kraemer Drive. This drive consists of a wound rotor ac component, a dc component mounted on or connected to the same shaft, and a rectifier which converts the ac power from the secondary of the wound rotor component to dc. The dc power is then applied to the armature of the dc component.

By varying the field excitation to the dc component, an adjustable speed is obtained. The unit can be designed to have either constant horsepower or constant torque over the entire speed range, *Fig.* 3. In addition, the field power supply can be modified to work on most signal systems for automatic or preprogrammed speed controls. A fixed low speed for jogging or creeping is obtained easily, using the dc motor portion.

The rotating components use standard ac and dc motor construction. Models of this drive are available in all standard enclosures from dripproof to totally enclosed, fan-cooled. They feature compactness, high efficiency throughout the speed range, good inherent regulation (5 to 7½ per cent), and ease of changing speed using a simple field rheostat. The drive is normally limited in speed range to 3:1. It cannot be used for regenerative loads, but dynamic braking can be added for quick slowing or stopping. This drive has relatively high efficiency (80 to 90 per cent) over its entire speed range.

Constant Voltage dc Motor. This is a drive where constant voltage dc power is supplied by a motor-

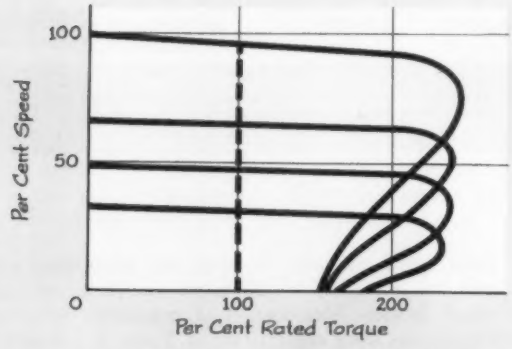


Fig. 1—Although not strictly an adjustable-speed drive, the multispeed ac motor performs usefully in many general machine applications. Speed-torque relationships for a typical four-speed motor are shown. Vertical dashed line illustrates constant torque capability.

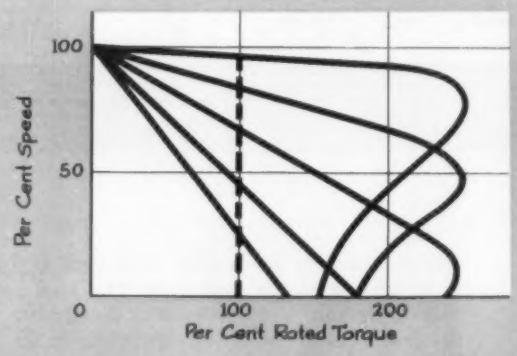


Fig. 2—A wound rotor motor can have a wide variety of speed-torque characteristics, depending upon the value of resistance inserted in its secondary circuit. Maximum starting torque can be developed with relatively little increase over full-load current.

generator set or rectifier with, in some cases, a transformer. Speed adjustment is obtained by varying the field of the dc motor.

The drive provides constant horsepower operation, *Fig.* 4, with slightly greater regulation than a standard dc motor. The limitation of the drive rests with the speed range available from the dc motor, which is usually 4:1. Special designs and ratings can be made for speed ranges of 6:1 and 8:1. The unit cannot be used for regenerative loads, but dynamic braking can be included.

Adjustable Voltage dc Drive with Motor-Generator Set. The classic way of obtaining adjustable speed has been to use an adjustable voltage dc drive. This uses a motor-generator (m-g) set to supply direct current to a dc motor. Speed control is obtained by a combination of generator voltage control and motor field control.

The adjustable voltage system is flexible, and

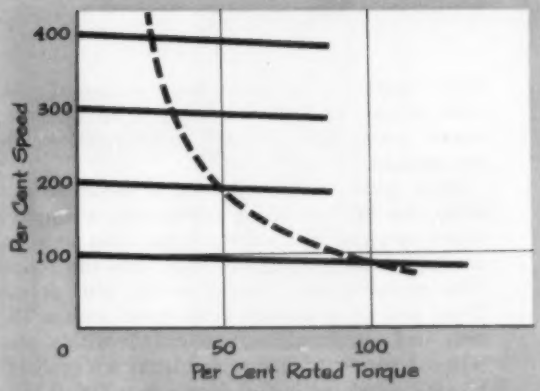


Fig. 4—Speed adjustment of the constant voltage dc motor is obtained by varying the motor field. Constant horsepower is available over a speed range of approximately 4 to 1.

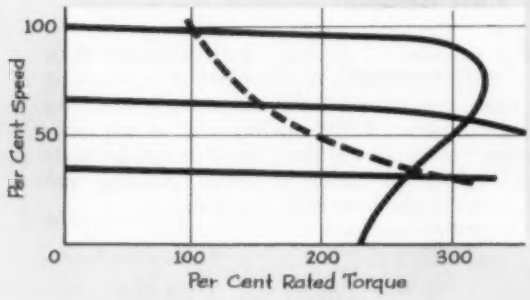


Fig. 3—Modified Kraemer drives are capable of either constant torque or constant horsepower operation. Normal speed range is approximately 3 to 1.

modifications can be made in the controls to adapt this drive to almost any adjustable-speed requirement. The drive has average efficiency; it is not as high as that for some other drives, but not as low as for the wound rotor or electromagnetic drives at low speeds. This drive can be supplied with any dc motor enclosure. By proper selection of the motor, both constant torque over the voltage range and constant horsepower over the field control range can be obtained, *Fig.* 5.

Adjustable Voltage dc Drive with Static Power Supply. An adjustable voltage dc drive, using a static power supply, is also available. Speed-torque characteristics are the same as those in *Fig.* 5. Units employing reactors and silicon rectifiers provide the adjustable voltage supply. In addition to the features of the m-g set type drive, this unit offers:

1. High efficiency (approximately 80 per cent at top speed).

2. Up to 50 per cent less floor space than the m-g set type.

3. Requires no reduced voltage starters since the circuit is closed on unsaturated reactors having high impedance in the unsaturated state.

4. Reduced maintenance through use of a static power supply.

5. Plus or minus 5 per cent speed regulation can be obtained, provided by the adjustable potential exciter.

The drive cannot be used on regenerative loads, but dynamic braking can be included for slowdown and stopping.

Electromagnetic Drives. This type of adjustable-speed drive consists of a standard squirrel cage induction motor driving an electromagnetic coupling. The coupling has two rotating members and a field that is excited from a dc power supply. With one member driven by the ac motor, excitation of the field produces eddy currents which cause the other member to rotate. Varying the field strength changes the slip and, hence, the output speed. The rotor connected to the output shaft has a large number of "interdigitated" poles of special shape to produce the most desirable torque characteristics.

In order to avoid the use of slip rings, and thus increase reliability and reduce maintenance of the coupling, the field coil is mounted on the end bracket of the coupling and projects into an annular pocket in the rotor. The extra air gaps thus created between the coil support and the inner and outer surfaces of the annular pocket do not affect operation of the coupling. Significant eddy currents and torque are not produced at these air gaps because the gaps are smooth and do not produce flux concentrations.

The drum in which the eddy currents (and hence heat) are generated is used as the constant speed

input member in order to obtain maximum cooling, even when the output member is running at reduced speed. Both air and liquid-cooled couplings are available.

Since good speed regulation is desirable in the drive, the field excitation system uses a simple regulator operated by a voltage signal from an ac tachometer which is integrally built into the coupling. This provides speed control within plus or minus 2 per cent of maximum drive speed with a 75 per cent load change. Long-time drift is within plus or minus 1 per cent. Special regulators are available to provide speeds within plus or minus 0.5, 0.25, and 0.1 per cent.

A wide speed range is available since the limitation in minimum speed is dependent only on the signal from the tachometer generator. Standard drives can be varied as much as 17:1. The control is relatively simple since the power required in the field is low. Modifications can be made in the circuit to incorporate automatic or preprogrammed speed control.

Speed-torque relationships for the electromagnetic drive are shown in *Fig.* 6. It has the following characteristics:

1. The drive is not a torque multiplier. Hence, it can transmit only the torque of the ac motor. Thus, it is a constant-torque drive.

2. Because the coupling must dissipate slip losses (or the difference between the input and output horsepower) as internal heat, drives rated over 15 horsepower are usually limited thermally to intermittent duty at very low speeds. External means of cooling, such as circulating water, can overcome this limitation. If the drive must be enclosed due to dust or other foreign material, it may be necessary to use water for cooling the coupling.

3. Due to the high slip losses at low speed, the efficiency is low at full torque.

Final Selection

The selection of the best adjustable-speed drive for a given application is accomplished by knowing the possibilities of each drive and carefully matching the requirements of the machine tool to the characteristics of the drive. Final selection can be made when all economic factors of initial, operating, and maintenance costs have been evaluated.

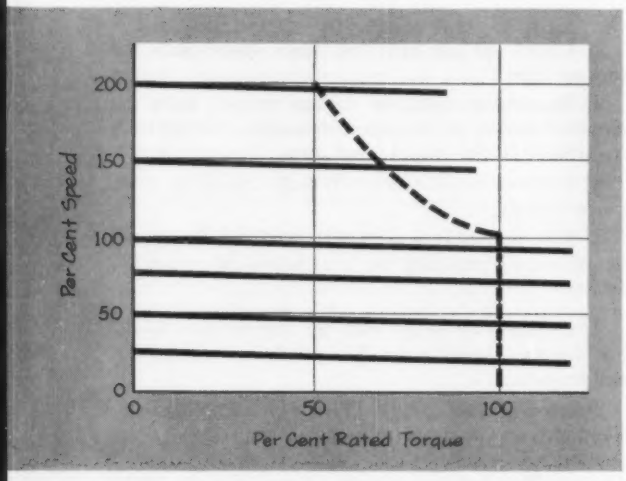


Fig. 5—Adjustable-voltage dc drives can supply either constant torque or constant horsepower, depending upon adjustment of voltage or field. Motor power may be supplied from motor-generator sets or static units.

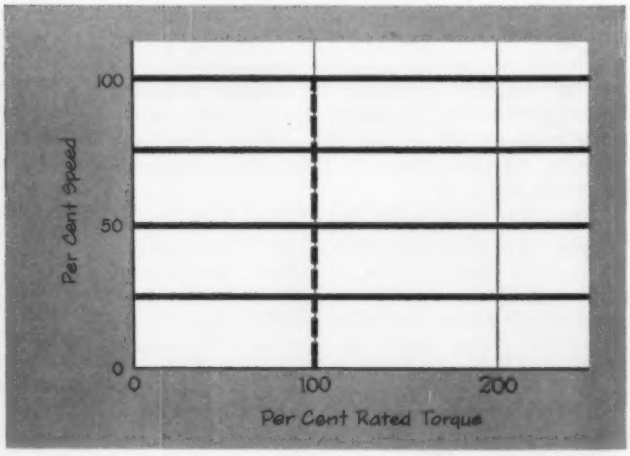


Fig. 6—Adjustable-speed, constant torque operation may be obtained with a standard squirrel cage induction motor equipped with an electromagnetic coupling. Speed range of a two pole unit is 34 to 1.

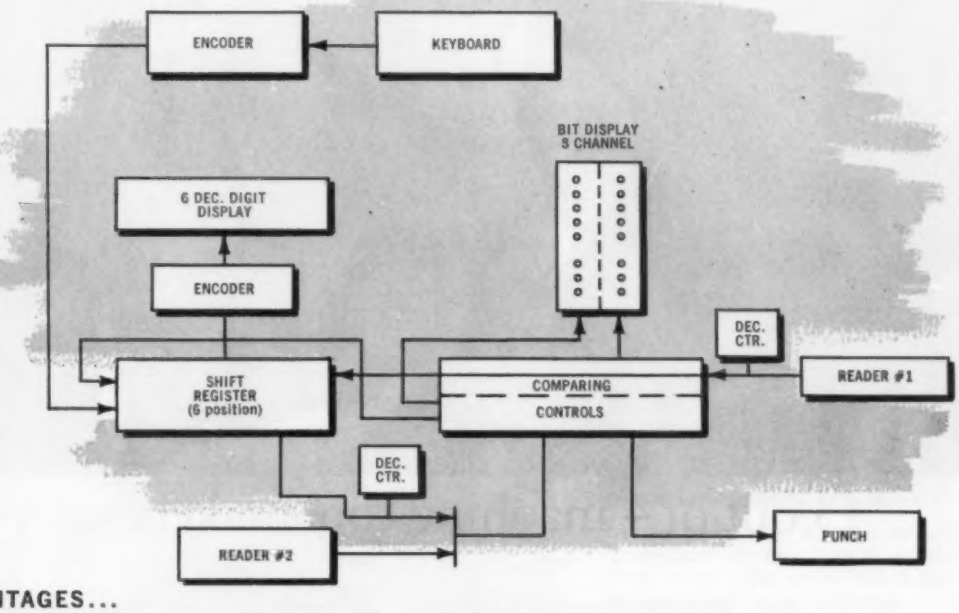
One sound solution
to the problem of quickly providing error free paper tapes to program equipment ranging from machine tools to satellite communications gear is Tally/Seattle's Model 150 Tape Console.

Here is a device which fully automates tape production. It is the only unit available specifically intended for the high speed preparation, verification, and duplication of error free perforated tape.

Tally tape consoles are available in either vertical or horizontal cabinets.

SIMPLIFY AND AUTOMATE

PUNCHED PAPER TAPE PRODUCTION WITH THE NEW TALLY TAPE CONSOLE



Schematic Arrangement of Components in Tally Tape Console

Basically, the unit consists of an alpha numeric keyboard, control and comparison section with six-digit decimal display, two tape readers and one tape perforator.

ADVANTAGES...

1. *Overall system flexibility and versatility with full operator control.*
2. *Keyboard entry to shift register and visual display which lets the operator edit keyed information prior to actual tape punching.*
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4. *Tape to tape duplication and/or verification at up to sixty characters per second.*

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SPECIFICATIONS—OPERATING SPEED: Variable from 0-60 characters per second. STANDARD CODE CHANNELS: 5, 6, 7, or 8. STANDARD TAPE WIDTHS: 0.687, 0.875 and 1.000 inch (interchangeable). SUPPLY AND TAKE-UP: 6" reel for 400' maximum; 10" reel for 1000' maximum; Fan Fold for 400' maximum. CODE HOLE SIZE: 0.072" diameter on standard 0.1" centers. FEED HOLE SIZE: 0.047" diameter. ALIGNMENT: Code holes and feed holes have a common center line. POWER REQUIREMENTS: 117 vac ±10%, 60 cps, 500 watts. DIMENSIONS: 51¼" H x 20⅝" W x 23⅜". PRICE, f.o.b. Seattle: $8,000.

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5

Circle 682 on Page 19

Is punched tape really the best input medium for numerical control?

(3 out of 4 machine tool makers say yes!)

Although 8-channel punched paper tape is only one of several numerical control input media, it is fast becoming the standard. Better than three-quarters of all builders of numerically-controlled machine tools now offer punched paper tape control. Why the swing to punched paper tape? There are three fundamental reasons:

1) Paper tape coding is visible, tangible. You can see it, touch it, and with practice even read it.

2) Paper tape is continuous. Unlike cards, it can't get out of order.

3) Paper tape is easy to program—preparation, verification, and reproduction of tapes are all handled on one inexpensive machine, the Friden Flexowriter® (illustrated).

For the machine tool buyer, standardization on paper tape means great savings. It's so much easier (and less expensive) when *one* input system can control *all* of the numerically-controlled machines in a given plant.

If you're thinking numerical control, you'll be way ahead to think *punched paper tape.*

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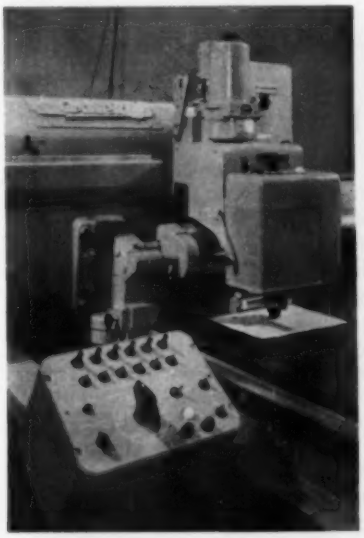
Tracer Controlled Shape Cutter

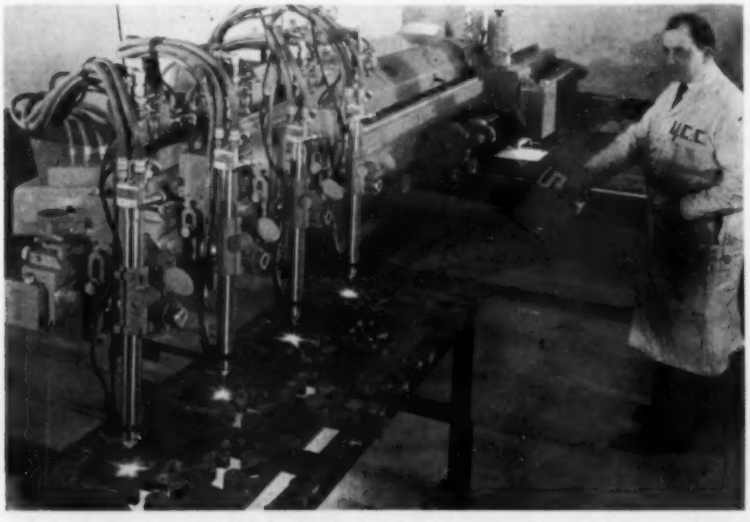
SHAPE-cutting machine can accurately reproduce metal parts from single exact size pencil or ink drawings. Designed by **Linde Co., Div., Union Carbide Corp.**, 270 Park Ave., New York 17, N. Y., Model CM-56 features a drive principle (designated Roller Drive) which removes the drive wheel from the template table. With this machine, a main rail carriage running on the main rails carries another pair of rails supporting the transverse carriage. Both carriages can follow and cut metal parts and forms of any shape, or either carriage can be locked. This makes it possible to produce straight and accurate cuts parallel to the main rails or at exactly 90 degrees to the main rails.

The photocell tracer with built-in kerf adjustment follows sketches on ordinary paper. Drawings of parts are made or traced in the exact size of the part desired. The kerf compensator dial is then set for the plate thickness being cut and compensates for kerfs up to ¼-inch wide, so that reproduced parts are exactly the same size as the line drawing. Wear on templates and cover sheets is eliminated since neither the machine nor tracer comes in contact with the drawing or tracing surface. Tracing accuracy is ±0.005-inch. Ordinary light, sunlight, or shadows do not interfere with the precision operation of the tracer. The tracer can negotiate 90-degree turns with 1/16-inch radius at speeds up to 16 ipm and 90-degree turns with ⅛-inch radius at speeds up to 27 ipm.

Three models are available. The 10-foot model carries up to 8 torches, the 7½-foot model up to 6 torches, and the 5-foot model up to 4 torches. Preheat gases and cutting oxygen are controlled by solenoid valves large enough to assure an adequate gas supply for multitorch operations. Each torch has an individual cutting oxygen solenoid valve to assure instantaneous shut-off of gas, eliminating overrun at the end of a cut. Valves are controlled by electric switches on the control panel. Each torch has individual valves for fine adjustment of the preheat gases and a shut-off valve for the cutting oxygen. Motorized torch holders pro-



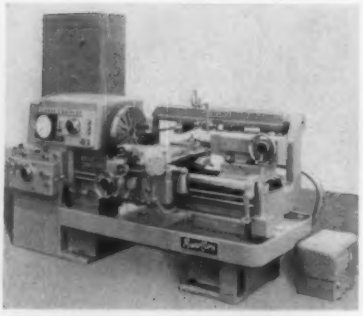
The photocell tracer is being guided by an exact size pencil sketch on ordinary paper. The shape that is being reproduced is the one shown in the other illustration.



Shape-cutting machine has a patented drive principle which removes the drive wheel from the template table. The machine in the illustration can carry up to 6 torches.

vide automatic up and down adjustment of all torches. An automatic height adjustment control is available. This unit rides the plate in front of the torches and senses deviations in levelness of the plate surface. The motorized torch holders react instantly, lowering or raising the torches to compensate for any deviation.

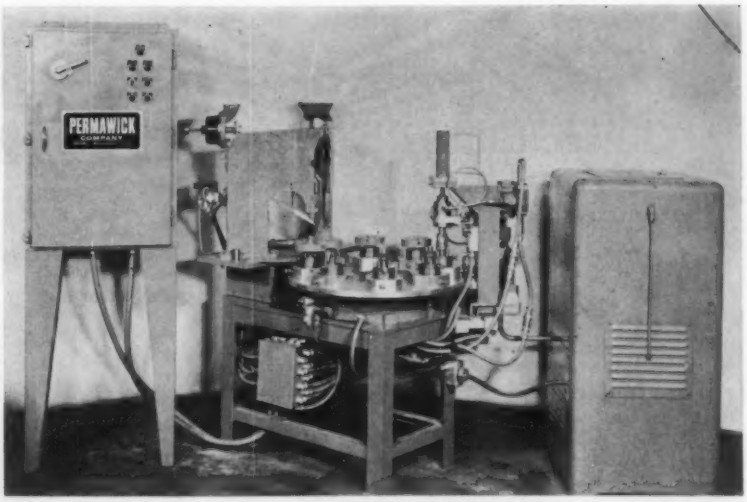
Circle 401 on Page 19



Tracer Lathe

Machinery provides constant cutting speed at any point, regardless of contours. It is available in sizes from 2013 to 3220-37. The lathe headstock is equipped with a 24-speed transmission plus a variable speed drive which permits infinitely variable control of each speed, with automatic or manual speed control. Feature of the lathe is the operation technique designated "combined feeds." It engages longitudinal and cross feed simultaneously to give a straight tool path in a line. Then the hydraulic cylinder needs to provide only for the differences from this path to the actual contour being machined. Cross feed and longitudinal feed in a 1:1 ratio give a tool path at 45 degrees to the centerline. Other features of the lathe include: End gearing to permit reduced feed rates for extremely critical surface finishes; a cross-center facing arrangement that automatically brakes and stops the spindle as the tool reaches the center line, reverses and restarts spindle rotation; and a special swivel arrangement that permits mounting of an integral type spindle for contour grinding. **Lodge & Shipley Co.**, 3055 Colerain Ave., Cincinnati 25, Ohio.

Circle 402 on Page 19



Assembly Machine for Integral Motors

Machine press-fits, rivets, or stakes complex assemblies, and injects a measured portion of fluid wicking, in a single operation. It is designed to automate the assembly and lubrication of end bells for fractional and integral horsepower motors up to 100 hp. A typical electric motor end bell assembly consists of two end-caps, bearing bracket, thrust plate, plate, and retaining ring. It can also be used to assemble automotive distributors and other small wick-fed bearing assemblies. Production rates are up to 750 assemblies per hour. With an indexing table, the unit designated Permapress, is adaptable to multistage assembly. Feature of the unit is the self-wicking lubricant which eliminates the need for hand inserting solid wicks. The lubricant, a blend of turbine grade oil and finely particled cellulose fibers, 85 per cent oil by volume, is injected during the press's cycle time. Volume of the injection is controlled to within 2/10 of a gram. In the event of an error in the assembly or lubricating process, a sensing switch stops the press. **Permawick Co.**, 5319 E. Outer Dr., Detroit 34, Mich.

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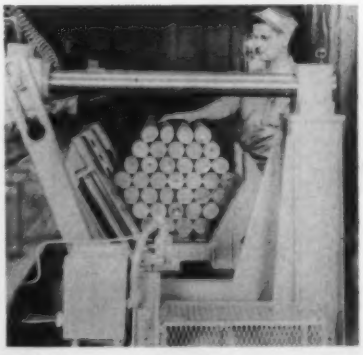
Bundling Machine for Billets

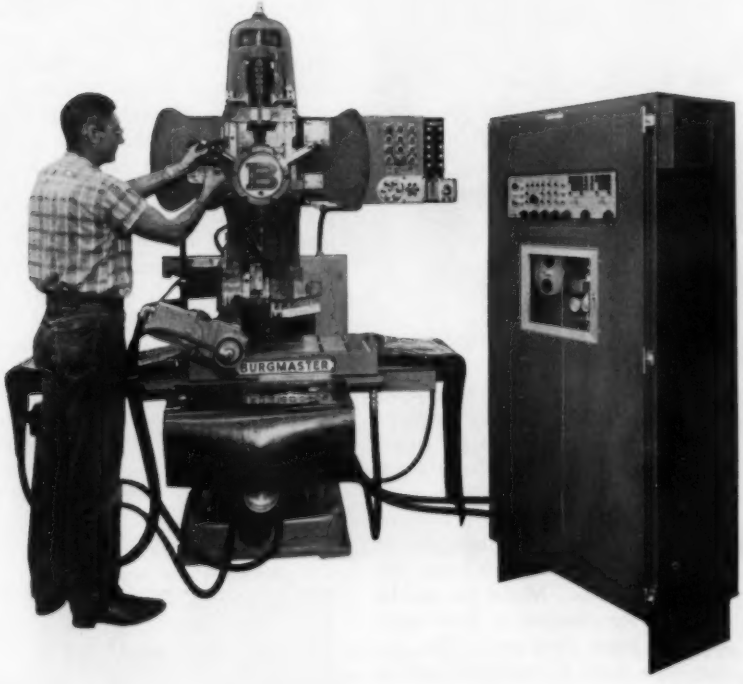
Equipment can package, into tight bundles, a wide range of piercing billets, extrusion billets, and wire bars. Two machines used in tandem can handle round billets up to 5 inches in diameter and wire bars up to 4 inches square, in lengths up to 72 inches. The provision of two machines in tandem allows one bundle to be strapped (either manually or by power strappers) and discharged, while the next bundle is being built up in the other machine. The round billets are bundled in a hexagonal pattern, while the square wire bars are stacked in a square arrangement.

In operation, a powered roller conveyor feeds the billets to the



bundling machine from such prior operations as casting, sawing, cupping, scalping, or inspection. The individual billets are picked up by a lifter and are moved by loading levers into a transfer arm. The

lead time cut over 50%— $3,000 saved on tooling with Hughes Tape Controlled Burgmaster



PROBLEM: To drill, countersink and tap 69 holes, including radial locations, to close tolerance in 50 missile bulkheads.

SOLUTION: Hughes All-Electronic Numerical Controls, a precision Rotary Table, the Burgmaster Turret Drill with two-axis positioning table, and existing simple fixtures and clamps. The need for complex multi-base drill jigs and other expensive tooling was eliminated.

RESULT: Hughes Tape Controlled Burgmaster saved over $3,000.00 in tool design and manufacturing time. Lead time was reduced by five weeks.

Hughes All-Electronic Numerical Controls are completely transistorized—and are immediately available for use on new machines or for retrofit of older units. These controls are now offered as standard equipment with Burgmaster Turret Drilling Machines.

For more information on how you can increase your profits with a Hughes Tape Controlled Burgmaster, contact your local Burgmaster Representative. Or, write:

HUGHES Industrial Systems Division, P.O. Box 90904, International Airport Station, Los Angeles 45, California.

For export information, write: HUGHES International, Culver City, California.

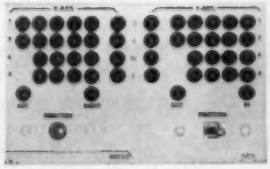
Creating a new world with ELECTRONICS

HUGHES

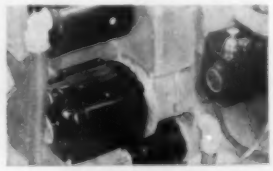
INDUSTRIAL SYSTEMS DIVISION
HUGHES AIRCRAFT COMPANY

Trouble-free operation; easy electrical maintenance: Transistorized circuitry and modularized construction assures you uninterrupted production with low power consumption; simple replacement and repair. *No service contract needed!*

Longer tape life with extra accuracy: Sensitive photo-electric tape reader eliminates deformation of tape holes; reduces possibility of tape wear and tearing. No pneumatic or hydraulic connections required for tape reading operation.



Easier set-up and program checking: Display lights on control panel indicate coordinate dimensions enabling operator to verify the accuracy of programming quickly and easily. Control panel human-engineered for maximum efficiency in operation.



Fast, accurate positioning; easy mechanical maintenance: Drive package positions table at 180 inches per minute; repeatable accuracy: ±0.0002", non-cumulative. Use of standard industrial electric motors and clutches assures quick repairs.

stroke of the transfer arm is determined by a signal obtained from the templet which actuates the automatic program control. Once the transfer arm travel stops, the loading levers are retracted and the billet drops into the cradle. The arm then returns and is ready to pick up the next billet, repeating the cycle. **Loma Machine Mfg. Co. Inc.**, 114 East 32nd St., New York 16, N. Y.

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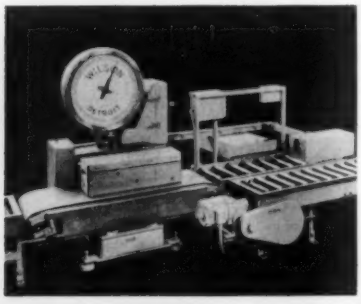


Printing Weigher

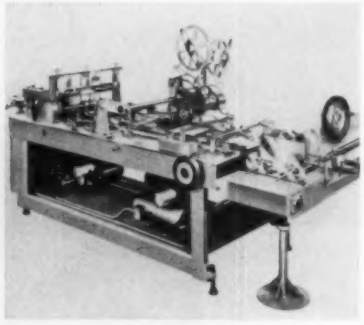
Device automatically weighs carton or container and stamps the weight directly on it. A complete unit can be furnished with conveyors, walking beam, or other mechanisms which transfer the object from the load station, to the scale, to the stamping equipment and beyond if required. Production speeds to 600 units per hour are possible, depending on the size of the package and the weight range. **Wilson Automation Co.**, 27101 Groesbeck Highway, P. O. Box 3855, Detroit 5, Mich.

Circle 405 on Page 19

Viscous Filler

Line of automatic, high-speed filling machines is capable of injecting viscous compounds into circular openings (such as molded shells) up to 2 inches in diameter. Various types of mastic of putty-like consistency are extruded in the form of a continuous band for injection into the components. The machines have variable volume-controlled filling cycles that are compatible with the material being dispensed. In operation, parts to be filled are automatically fed from bulk hoppers at production rates ranging from 3000 to 18,000 units per hour, depending on the characteristics of the parts to be filled and the specifications of the filling substance. **Swanson-Erie Corp.**, 814 East 8th St., Erie, Pa.

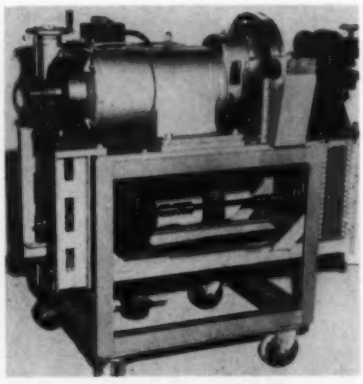
Circle 406 on Page 19



Label Applicator

Unit can apply preaddressed labels from punched cards, magnetic tapes, plates, and stencils; to magazines, newspapers, tabloids, catalogs, flyers, and other printed pieces at speeds of 30,000 pieces per hour. The labels can be in the form of roll strip, continuous pack form, and tape strip labels. Model SL can be adjusted for changes in label position or piece thickness. The rotary-type head is equipped with a photoelectrically - controlled throw-out which prevents lost labels. Zone, club, and singles separations can be automatically made on the variable-speed conveyor. A reciprocating-action feeding mechanism enables pieces to be fed at the same speeds as machine rollers, preventing jam-ups. Pieces can be added without stopping the machine, and label and glue supplies can be replenished while the machine is in operation. **Cheshire Inc.**, 1644 N. Honore St., Chicago 22, Ill.

Circle 407 on Page 19



Extrusion Cutter

Applicable for high-speed processing of extruded plastics, rubber, and other materials, Model IV-S features a pinch-roll feed that is synchronized with the action of the cutting blade. The pinch rolls are driven from the cutter motor through a variable speed transmission (to adjust length of cut) and through non-slip timing belts. The high-speed shaft has a rear extension, and on this is mounted a balanced 20-lb flywheel and a driving pulley for the pinch-roll feed. The inertia of the rear flywheel rotating at up to 4000 rpm, added to the inertia of the 40-lb cutter head rotating at about one quarter of that speed, provides a greater precision in the intervals between cuts by eliminating any minor variations in speed or pulsations. **Foster & Allen Inc.**, 26 Commerce St., Chatham, N. J.

Circle 408 on Page 19

Parts Cleaner

Device is designed for use on assembly lines to clean parts such as diodes, transistors, pivots, vibrators, voltage regulators, and vacuum tube

The sensational Cenozoic Towel Fold-o-matic,
Piltdown-Patented in 113,003 B.C.

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Circle 685 on Page 19

A NEW, ULTRA-SONIC, NON-CONTACT SENSING AND SWITCHING SYSTEM

SONAC

* Here truly is a new dimension in automated controls! Delavan's new SONAC uses ultrasonic energy for its "beam". This new concept offers many advantages over available sensing devices. SONAC has no lamps to burn out . . . nothing to replace . . . eliminates down time. SONAC is unaffected by vibration, dust, industrial contamination or ambient light. SONAC will sense ferrous and non-ferrous metals, liquids or solids, transparent or opaque materials, yet requires less power than an ordinary flashlight. These are a few of SONAC's advantages.

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*Sonac is a trade mark of the Delavan Manufacturing Co.

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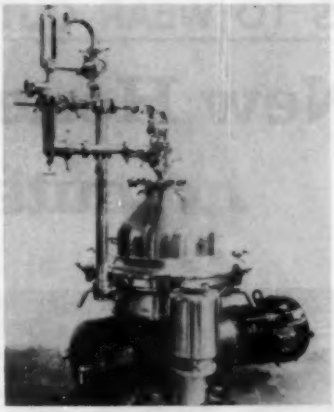
components. It cleans at a rate of 900 parts per hour. In operation, parts are mounted around the periphery of a rotary turntable and automatically indexed to successive spray-clean operations. A finely atomized spray of solvent is combined w th heated and filtered air and directed against all areas. Oil, grease, fingerprints, and other soluble and insoluble contaminants are removed in seconds without leaving deposits of film or residue. An integral ventilation system exhausts all vapors. **Cobehn Inc.**, Passaic Ave., Caldwell, N. J.

Circle 409 on Page 19

Electronic Computer

Desk-size electronic computer can be used for engineering and scientific calculations, statistical and business data processing, data conversion, data logging and data acquisition, industrial control, and communications systems. Model 160 computes in terms of microseconds and can execute 60,000 instructions in one second. It handles data transmissions to and from input-output equipment at speeds up to 65,000 characters per second. Computer is a single-address unit with high-speed parallel mode of operation. Storage cycle time is 6.4 microseconds. Basic add time is 12.8 microseconds. Information read is available 2.2 microseconds after the start of the cycle. It has a repertoire of 62 instructions and a programming package which includes 22, 33, and 44-bit fixed point arithmetic, floating point, complex floating point, decimal, floating decimal, and an algebraic compiler. **Control Data Corp.**, 501 Park Ave., Minneapolis 15, Minn.

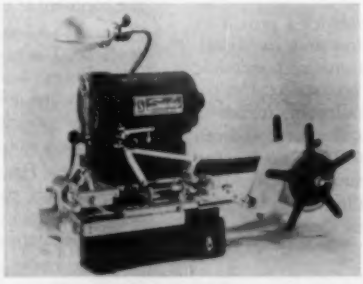
Circle 410 on Page 19



Automatic De-Sludger

Applicable in the chemical and food processing industries, self-cleaning clarifier ejects sludge automatically. Some of the applications include the clarification of vinegar, whey, coffee, and tea extracts. Model SAMN-5036 is designed for continuous operation at capacities of 500 to 3500 gph. It provides either complete or partial desludging. With the partial desludging, only solids are ejected without losing valuable liquid. The desludging cycle can be controlled by an automatic timing unit which allows ejection of solids at preset time intervals; as often as every 45 seconds if necessary. The machine has stainless steel construction throughout the bowl and all other liquid and sludge contact parts. **Centrico Inc.**, Englewood, N. J.

Circle 411 on Page 19



Tag & Label Marker

Equipment imprints product identification on tags or labels. Model 23 is fully automatic; marks, counts, cuts, stacks (or rewinds) tickets and labels at a rate of 144 per minute. It will imprint labels up to 4 by 2¾ inches. Types of tags that can be used include: Bolt, folded fabric, and apparel tags, available as prestrung hang-tags with a reinforced seal-strip anchorage, or in a wide assortment of unstrung tags for specific attaching methods. Types of labels that can be handled include a variety of gummed, pressure sensitive, and heat-seal labels that are used on board, package, and box ends, or on cones, cores, tubes, and filmed surfaces. **Soabar Co.**, 4219 E. Van Kirk St., Philadelphia, Pa.

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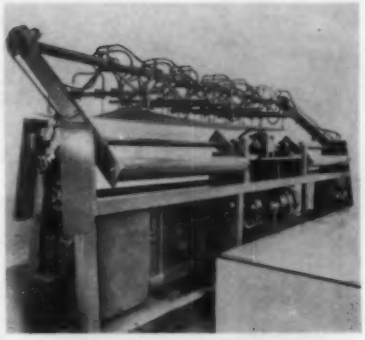


Overarm Sheet Feeder

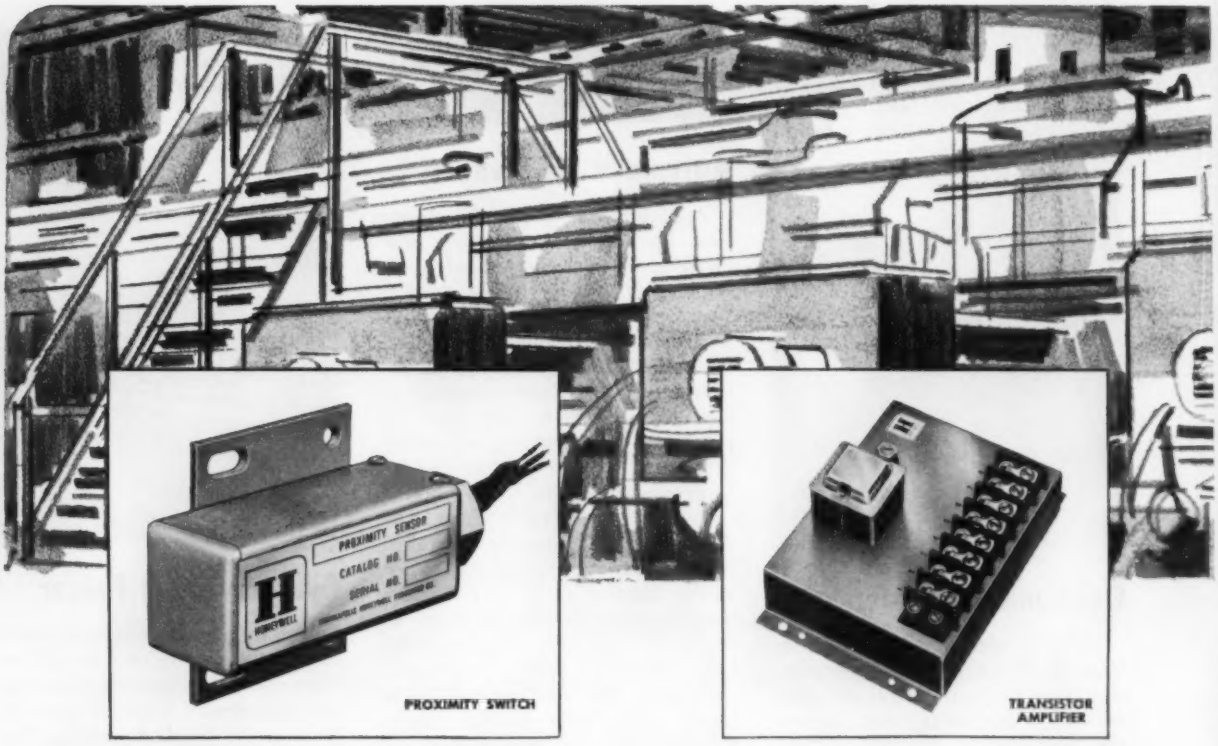
Overarm feeder can feed sheets, ranging in size up to 6 by 20 feet, from a pile to processing or conveying equipment. Types of materials that can be handled include: Plastics, cardboard, metal, and asbestos board. It is hydraulically operated, handles rectangular or irregularly shaped sheets, flat or formed sheets (corrugated for example), and can pick up or deliver sheets vertically as well as horizontally.

In operation, the feeder grasps sheets by means of vacuum cups supported on a carrier which is mounted between two oscillating arms. As the arms rotate from one side of the machine to the other, they first lower the carrier to engage a sheet on one side, and then transfer carrier-and-load to the other side, where the vacuum is released and the sheet deposited. The carrier automatically returns for another sheet unless the machine is set for single cycle operation. **The de Florez Co.**, 200 Sylvan Ave., Englewood Cliffs, N. J.

Circle 413 on Page 19

NO MOVING PARTS TO WEAR OUT!

New Honeywell Static cuts down time,



Never before such dependable control of pneumatically-operated power cylinders!

This new electro-pneumatic power team includes a proximity switch with a transistorized amplifier to transmit its signal. This output is fed directly to the coil of a unique pneumatic valve, providing high-speed static switching up to 600 cycles per minute. The system is so adaptable and foolproof, it can be used to meet almost any production line requirement, and can be expected to last the life of the equipment. With no moving parts, it needs no maintenance or lubrication, and offers the utmost in reliability. Especially designed for industrial environments, it is impervious to dust, water, oil and abrasives.

New Honeywell Proximity Switch tackles tough automation problems

This industry proven switch will stimulate new ideas for updating machines and methods. It detects metal parts that pass within ½" of the sensor without ever touching them. It will operate up to 600 times a minute at temperatures up to 200 degrees F. And it needs no warm-up time—it's ready to operate the moment it is energized.

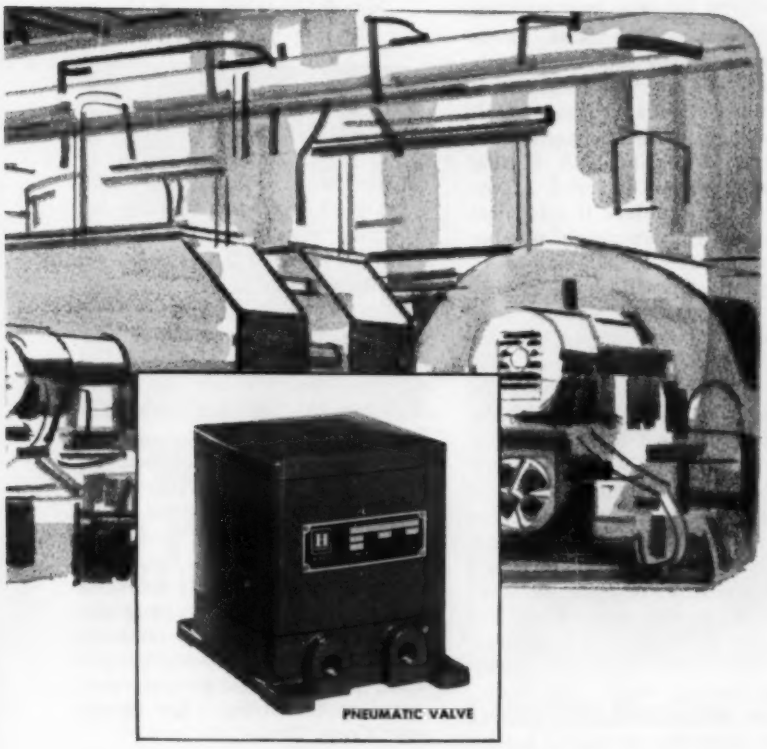
Because it has no moving parts to wear out, it need never be replaced. The rugged stainless steel face is sealed against cutting oils, filings, humidity, sand and dust. The sensor can even operate when it is submerged. And it's simple to install because there are no mechanical actuators or linkages to adjust. It operates on normal line voltages.

This new Honeywell Proximity Switch is the perfect answer where rough parts or corrosive atmosphere may damage a mechanical switch, or where the delicate finish of a product might be marred by physical contact.

The transistorized amplifier, containing a field-proven Honeywell circuit, gives sensitivities from 1/16" to ½" at the sensor. The transistors mean no warm-up time is required and the sensor will operate instantly. Amplifier can be mounted up to 150 feet from the sensor and wiring need not be shielded. JIC enclosure available.

See us in Sweet's 1960 Product Design File, Section 5b-Min

Power Team speeds production



Most reliable pneumatic valve of its kind is designed to last up to 40,000,000 cycles

At last, here's a valve built to give service rather than to be serviced. And you'll find it the most adaptable pneumatic valve ever designed for transfer line, punch press and welding machine operations.

A change of manifolds permits either ¼", ⅜" or ½" valve sizes—makes it a 3-way or 4-way valve. Reverse the power head and you change it from a reverse to a direct-acting valve. Even the porting arrangements can be changed.

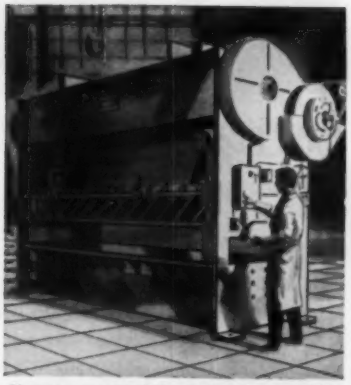
What's more, you get fast response (up to 600 cycles per minute), high capacity, with little or no maintenance required. The coil life is guaranteed for the life of the valve. For long, trouble-free service and money-saving features, no other valve compares with Honeywell's new V4032A, B and V4033A. Built to JIC specifications.

For additional information on the static power team or on any one of the components, call your local Honeywell office. Or write Honeywell, Minneapolis 8, Minnesota.

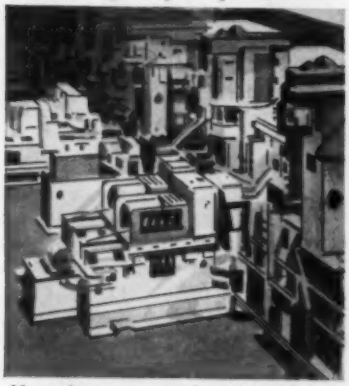
75th YEAR — PIONEERING THE FUTURE

Honeywell

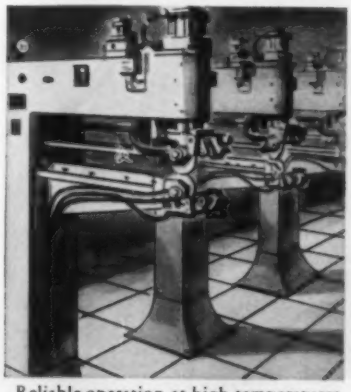
H HONEYWELL — First in Control — SINCE 1885



Fast response and long life solve two big problems in power press operation.

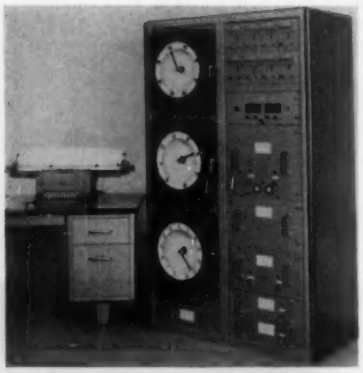


No maintenance or lubrication required reduces down time on transfer lines.



Reliable operation at high temperatures make this team ideal for spot welders.

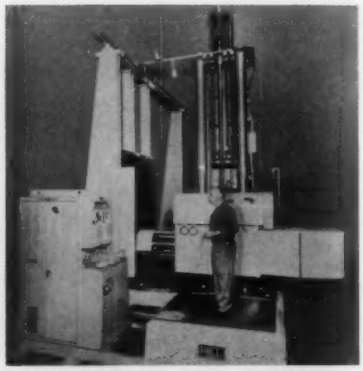
Circle 687 on Page 19



Data Recording System

System can measure and record up to 75 iron constantan thermocouple inputs. It is applicable wherever the recording of temperatures is desired on either a round-the-clock or intermittent basis. The digital output is presented automatically on an electric typewriter. System consists of an input scanner, self-balancing potentiometers, shaft encoders, encoder selector, control chassis, programmer, digital clock, and an electric typewriter. The three temperature ranges provided are −30 to 120 F, 250 to 600 F, and 0 to 1200 F. It is accurate to ±1 F in the first two ranges and ±5 F in the third range. Scanning rate is 3 seconds per data point; the cycle can be initiated automatically ½ to 3 minutes after completion of the last logging cycle. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 414 on Page 19



Tape Controlled Jig Drill

Numerically controlled jig drilling machine is designed for programmed drilling of holes in parts or groups of parts measuring up to 10-ft square. The machine is adaptable to the drilling of hole patterns and bolt circles in condenser tube sheets. Condenser tube sheets or vessels longer than 10-ft but within the 10-ft height dimension can be handled on the machine by indexing the part horizontally and floating in the correct zero setting for tape programming.

In operation, the work to be drilled is clamped in a work fixture and held stationary while the head carrying the drill is moved vertically and horizontally to programmed positions for drilling. A floating zero arrangement included in the General Electric Mark II numerical control system enables a number of smaller parts to be clamped simultaneously in the work fixture and accurately drilled under tape control. The machine can produce holes by either gun drilling, pressure-coolant reaming, grooving or drilling with oil-flute twist drills. A bushing plate on the head operates automatically in sequence with the drill to permit either gun drilling or oil-flute drilling operations to be performed. Bushing plate advance and retraction functions are programmed into the drilling cycle on the tape. When oil flute twist drills are used to produce holes, an oversize bushing is placed in the bushing plate. This bushing does not guide the tool initially, but serves the purpose of breaking up chips and restricting coolant flow. A motorized chip conveyor removes chips from the work area of the machine. **Walter P. Hill Inc.**, 22183 Telegraph Rd., Detroit 19, Mich.

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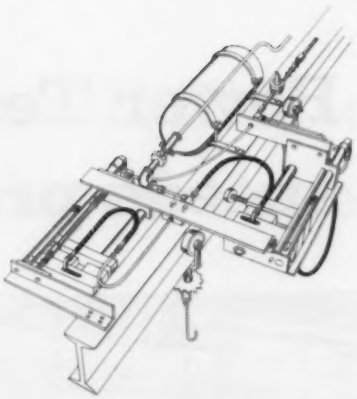

Conveyor Lubricator

Self-contained trolley lubricator operates automatically by remote control from the floor level, can get at hard-to-reach trolley fittings. It will service trolley conveyor wheels with no maximum limit to wheel spacing, and with no limit to irregular wheel spacing. The unit will lubricate four-inch conveyor wheels traveling at a maximum speed of 75 fpm, with a minimum wheel spacing of 16 inches, or six inch trolley conveyor wheels traveling at a maximum speed of 60 fpm with a 24 inch minimum wheel spacing.

Unit consists of a left and right hand lubricating assembly, an electrically or pneumatically operated control panel, and a five-pound capacity lubricant reservoir mounted on a four-foot I-beam. Feature of the device is a fold-away mechanism that retracts the lubrication unit out of position to prevent damage to the lubricator or trolley conveyor in the event that the trolley wheels in the conveyor system become broken or damaged. In operation, the device delivers a predetermined, measured amount (up to 0.025 cubic inch) of lubricant per shot. The lubricant cannot be discharged from the unit unless the coupler is properly connected to the fitting. **Aro Equipment Corp.**, Bryan, Ohio.

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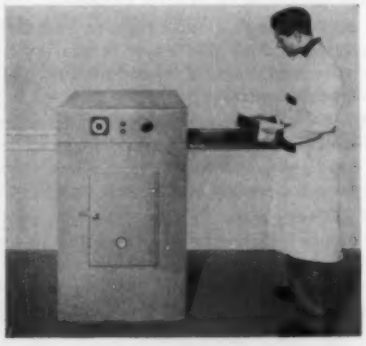
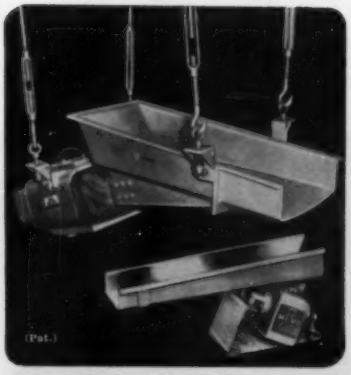


Heat Sealing Machine

Machine designated Blistomatic, heat seals packages through the card rather than through the plastic material. Feature of the machine is a

ACCURATE AUTOMATIC FEEDING

from ounces to tons per hour



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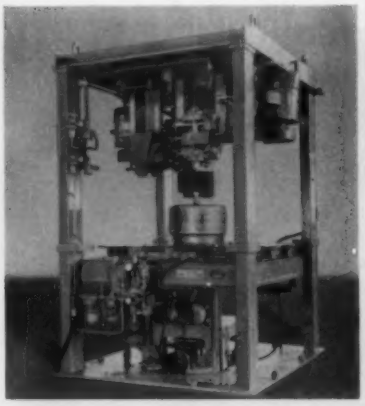
ERIEZ

Circle 688 on Page 19

flat, steel loading tray. It is engaged by a master plate which forces the blister-laden tray against the hot die for sealing and presses the plastic into the card surface. Machine can be operated at high temperatures without danger of deforming the plastic blister or causing excessive card warpage. Other features of the unit include two timers which automatically control the sealing time cycle. The index timer sets the quantity of production and the dwell timer regulates the amount of time heat is applied. **Tronomatic Machine Mfg. Corp.**, 25 Bruckner Blvd., New York 54, N. Y.

Circle 417 on Page 19



Deburring Machine

Machine automatically deburrs holes in prepartion for spray-finishing in items such as automatic washer and dryer baskets. Four wire brush heads are used to deburr the baskets in a ten second cycle. Three operations occur simultaneously. Two of the wire brush heads deburr the holes on the outside of the basket; another wire brush head deburrs the holes in the bottom of the basket; and a fourth brush removes the scale from the inside welded seam which secures the sides to the bottom of the basket. Deburring machine can be used as an individual unit or as part of an automated production line. When it is used as part of an automatic form and weld line, the baskets are moved from one machine to another by means of transfer arms. As a basket reaches the deburring machine, it is raised into brushing po-

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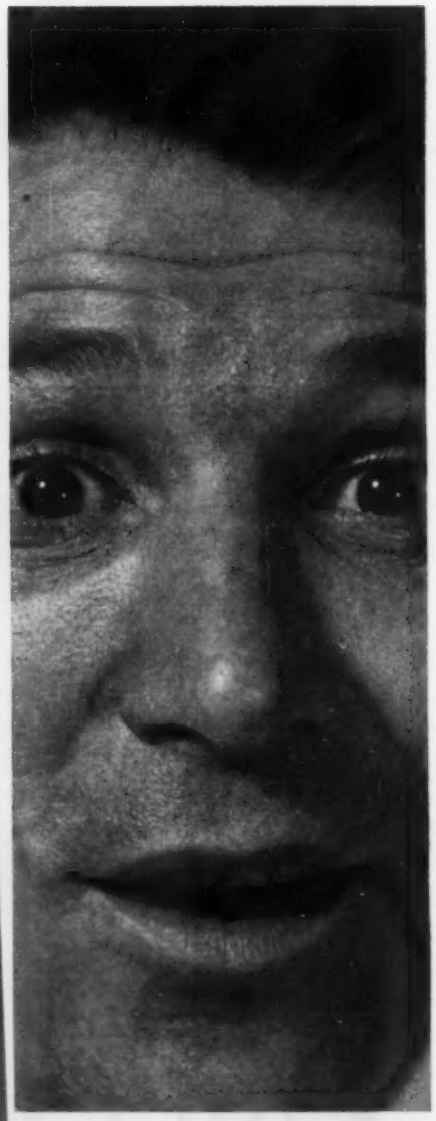
"what really excites



†*manufacturing engineering function*

ME† . . . is how fast . . . how extensively . . . my own company has moved into automation. Five years ago, no one . . . not even myself . . . dreamed that automation would be the rule, rather than the exception, in *our* industry. Nor did anybody guess how quickly . . . how definitely . . . the Manufacturing Engineering function would grow in importance in our plant. Such progress is bound to excite **ME**. The technology itself. AUTOMATION, the magazine that sets the pace for it. From its editorial pages I adapt successful ideas from *all* industries and apply them to my own projects. From its advertising pages I select products that turn plans into production-at-a-profit. No wonder I'm excited! No wonder my excitement is catching! Advertising in AUTOMATION has increased by more than 30% since last year! Are you with **ME**?"

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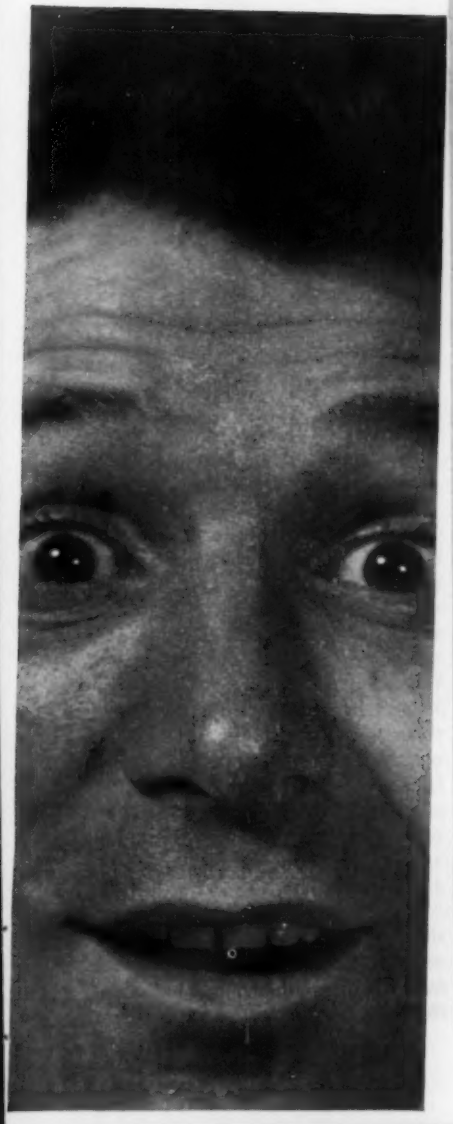

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first for the Manufacturing Engineering function

sition and rotated while the four wire brushes complete the deburring action. Then it is lowered into pass line position where the automatic transfer arms remove it and replace it with another basket for deburring. **Murray-Way Corp.**, P. O. Box 180, Birmingham, Mich.

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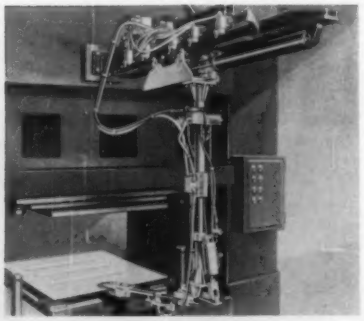

Press Mounted Extractor

Unit is mounted on the back of a press with heavy duty hinge type mounting brackets. It is adjustable to extract any type panel horizontally or on an angle. The vertical lift is adjustable up to 12 inches. One or more jaws can be mounted to extract single or multiple parts. The extractor is self-contained and requires only one electrical interconnection with the press to instigate the grab and extraction cycle. **Die & Automation Inc.**, 5353 Dixie Highway, Hamilton, Ohio.

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Tape Converter

Device converts paper tape to magnetic tape at the speed of 150 characters a second. The tape can be read by a computer at 15,000 or 22,500 characters a second. Model 7765 consists of a paper tape reader with photoelectric reading mechanism, and a magnetic tape writing unit. The photoelectric mechanism can read both chadless (punched flap) tape, and chad (punched hole) tape. The converter can handle paper tape in three widths —11/16, 7/8, or 1-inch tape and this can be in the form of reels, rolls, or strips. Features of the unit are thorough error-checking, and a center-roll feed device that eliminates the rewinding of paper tape rolls. **Data Processing Div., International Business Machines Corp.**, 112 East Post Rd., White Plains, N. Y.

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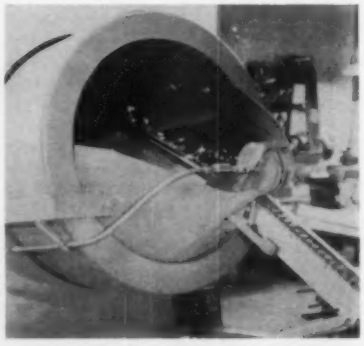

Parts Feeder

Machine features scrolled rollers for orientation of complex parts. It is designed to handle parts such as tapered units, conical sections, capped bottle stoppers, daubers, and wipers, as well as other components having a variable diameter along the longitudinal axis. The two motor-driven, counter-rotating rollers are positioned so the parts being fed travel in the valley between the rollers until the opening is wide enough to permit the smaller section of the part to fall through. This causes the part to travel in the direction of the rollers with the smaller cross-section downward. At the end of the rollers, the parts being fed are discharged to an appended track in such a manner that the parts are parallel to each other.

An alternative method of delivery is that the parts can be made to drop through the tracks by means of a suitable step-down in the cross-section of the tracks. With this method, the parts are dropped into a chute end to end, with the smaller cross-section leading. Feature of the unit is a motorized wheel mounted with its axis at right angles to the axis of the rollers. This wheel has a form such as to pass only those parts properly lined up on the rollers. Other parts not properly oriented are gently knocked off the rollers by the wheel and returned to the beginning of the track for another pass. **Aidlin Automation Inc.**, 1613 East New York Ave., Brooklyn 12, N. Y.

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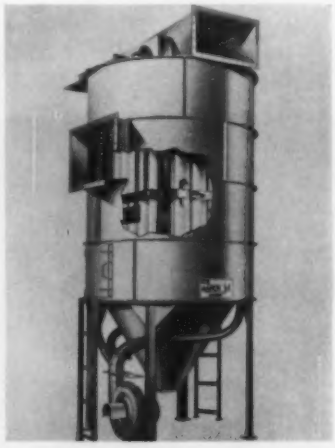


Fabric Dust Collector

Reverse-jet fabric dust collector is designed for applications where extremely fine particles are involved and where the material must be collected in a dry state for reclaiming, such as in cement plants, foundries, pharmaceutical plants, and food and fertilizer operations. In operation, dust-laden air is either drawn or blown into the inlet plenum at the top of the collector. The dust-laden air enters the filter bags through venturi-shaped inlets. Most of the dust precipitates to the conical hopper at the lower end of each filter bag. The very fine dust is held by the velocity of the air against the inside of the 9-inch diameter filter bag.

Dislodging of the fines from inside the bag is accomplished by a series of jet rings, one around each bag, which are moved up and down the filter bags. High pressure clean-

ing air is blown through annular orifices from the inside diameter of each jet ring. The air is introduced into the jet case assembly by a shoe which enters two neoprene rubber flaps mounted vertically in the open side of the air column. This also acts as a guide for the up and down path of the jet case assembly. Four heavy-duty, non-binding pintle chains are connected to the jet case to raise and lower the filter bag cleaning device. Using the reverse-jet cleaning principle, a nearly constant pressure drop across the collector can be maintained. Every square foot of the filter fabric is cleaned by using a positive air cushion to remove the entrained dust. **American Air Filter Co. Inc.**, Dept. PD, 215 Central Ave., Louisville 8, Ky.

Circle 422 on Page 19

Flame Photometer

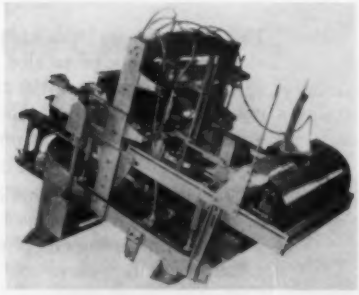
Analyzer measures the sodium ion content of boiler feed water and the chloride ion content of water whose principle chlorine impurity is sodium chloride. It can also be adjusted to measure other elements which exhibit flame emission such as boron, calcium, cobalt, copper, iron, lead, nickel, and titanium. Instrument consists of two parts: An optical unit and a control panel. The optical assembly houses the sample manifold, burner, monochromator, and photomultiplier. The control panel houses the high voltage supply, amplifier, automatic standardizing system, sample sequence selector, and the recorder.

The instrument is supplied with a five-point manifold system or with a single-point manifold system. In the case of a five-point manifold system, five sample streams continuously flow to the analyzer. Each of these sample streams is selected automatically in sequence and fed to the burner unit. The burner is supplied with hydrogen and oxygen which are regulated by precision regulators in the optical section of the instrument. When an emitting impurity is present in the sample, the flame emits the characteristic radiation of that material. Unit is provided with a high concentration alarm circuit. It can be set to operate at any point on the recorder scale. The circuit is provided with a time delay mechanism so that it does not operate until one minute after the recorder has gone above the predetermined point. This prevents any alarms due to temporary increases in sample. **Waters Associates**, 45 Franklin St., Framingham, Mass.

Circle 423 on Page 19

Case Opener/Former

Machine is applicable to cans, bottles, and other types of packaging requiring cardboard carton loading. Model CKCO-3 receives the corrugated shipping cases knocked-down, opens them, forms and positions them over the funnel of a packer, and then automatically discharges the filled cases to the infeed



of a gluer and compression unit. Machine can handle up to 40 cases per minute. Features of the unit are push-pull connectors that operate from a centrally located cam shaft and cam levers that control various motions of the machine. Guards keep carton fly-away from important motions and grease away from cartons. **Crompton & Knowles Packaging Corp.**, Holyoke, Mass.

Circle 424 on Page 19

NEW STROMBERG-CARLSON TELEPHONE HANDSET CRADLE

. . . for positive retention in all mobile applications

There's no jump, no sway—when a telephone handset is in the firm grip of this new handset cradle by Stromberg-Carlson.

Retaining clip spring assembly

assures positive retention in any mobile application on land or sea, or in the air. Even extremely severe jars, jolts and vibrations fail to dislodge the handset.

The cradle is strong and resilient, fits any Stromberg-Carlson handset. Different models provide varying switch combinations with 2 or 4 Form C contacts. All models available with or without the clip assembly.

Specifications on request. In Atlanta call TRinity 5-7467; Chicago: STate 2-4235; Kansas City: HArrison 1-6618; Rochester: HUbbard 2-2200; San Francisco: OXford 7-3630. Or write to Telecommunication Industrial Sales, 111 Carlson Road, Rochester 3, New York.

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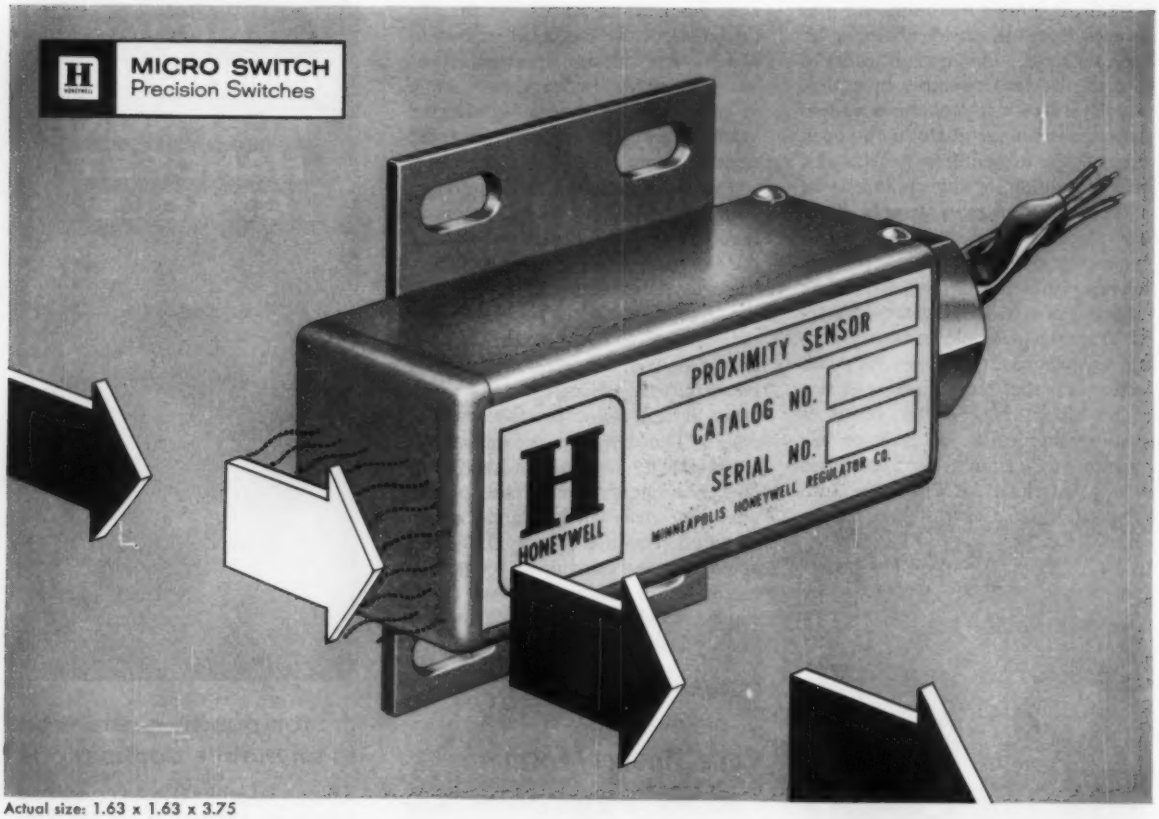
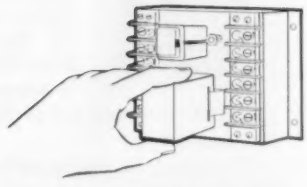
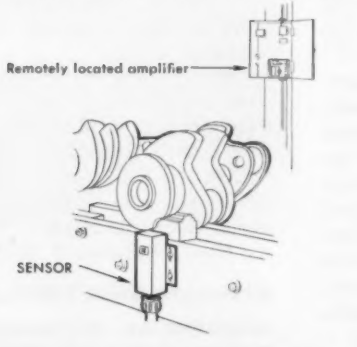


Actual size: 1.63 x 1.63 x 3.75

BUSY SWITCH
without a moving part!



Plug-in relay in amplifier cuts downtime.



Amplifier is separate, may be remotely located.

Honeywell Proximity Switch opens new ideas for up-dating machines and methods

This amazing new switch solves many automation problems that previously could not be tackled. It detects metal parts that pass within ½" of the sensor—over 600 operations a minute—without ever touching them. Perfect answer where rough parts or corrosive atmosphere may damage a mechanical switch or where the delicate finish of a product might be marred by physical contact.

The Honeywell sensor has no moving parts to wear out, need never be replaced! It has a rugged stainless steel face. The sensing unit is sealed against cutting oils, filings, humidity, sand and dust, can operate submerged if necessary.

A Proximity Switch can be your answer to difficult switch problems, but be sure it is a product of Honeywell research. Contact the nearby MICRO SWITCH branch office and ask for Data Sheet No. 163.

MICRO SWITCH, FREEPORT, ILLINOIS
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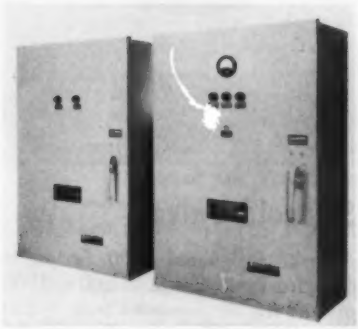
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.



Power Continuity Control

Magnetically controlled start-stop system for electric power switching operations is suitable for use at unattended facilities and installations requiring automatic switching. It can monitor both primary and secondary power sources, performing all necessary switching to insure a continuity of power. The start-stop control automatically starts either a diesel or gasoline generator set upon interruption of primary power and, when the auxiliary system reaches the proper voltage and frequency value, blocks out the primary source, and transfers the load to the auxiliary system.

Once the primary power source is restored, the switching group automatically shuts down the auxiliary system, returning the load to the primary system, and resetting itself to anticipate further primary interruptions. Feature of the unit is that it is designed with special circuitry that senses any deterioration (voltage, current, or frequency) in the primary power source. When it senses this deterioration, the auxilairy system is automatically started. The control is designed for operation on 50-60 cycle ac power lines, either 3 phase, 240 v 3 wire, or 120/208 v 4 wire. It is available in two power ratings, 15 kw or 30 kw. **Lumen Inc.**, Joliet, Ill.

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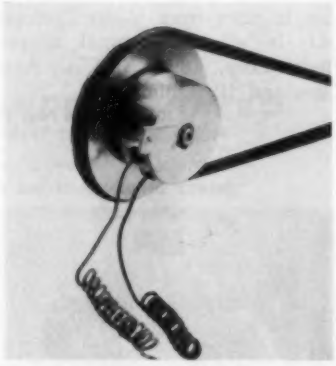

Disc Clutch

Miniature positive clutch is suitable for applications where a minimum space is available for the clutch. The positive acting crown teeth are magnetically engaged and spring released. The teeth are pitched for easy engagement at a low rpm. A smooth acceleration then drives the load. Model CT 14 is 1½ inches in diameter, with an overall length of ¾ inch. It develops 80 oz in. torque, and can be wound for 28 v dc. A sheave can be mounted on the driven hub which also serves as an armature. Other types of mountings are with worm gears and spur gears. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

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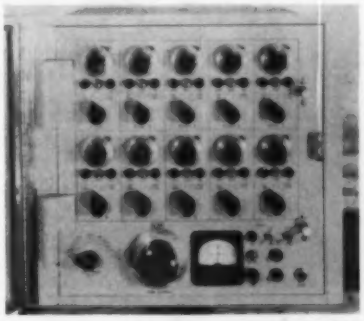

Temperature Controller

Ten-point temperature controller provides three modes of operation that can be individually selected for each of the ten controlled points. Each point on the control panel has a slave potentiometer, three indicator lights, and a selector switch. The slave potentiometer must be adjusted to a master calibrated potentiometer. The master potentiometer has a range switch adjustable in 100 F intervals from 0 to 1200 F and a vernier adjustable from 0 to 100 F in 1 F intervals. The sum of the range switch reading and the vernier reading is the actual set-point temperature.

The modes of operation available are: Set-point mode, adiabatic mode, and off-set adiabatic mode. In the set-point mode of operation, the instrument compares the emf from a thermocouple with the emf from a calibrated bridge and causes power to be applied to the output circuit when the emf of the thermocouple falls below that of the bridge. In the adiabatic mode of operation, the instrument compares a secondary thermocouple emf with the emf from a set point or vessel thermocouple and applies power to the out-

put when the secondary thermocouple emf drops below the emf of the set-point thermocouple. In the off-set adiabatic mode of operation, a positive or negative potential is added to the emf from a set-point or vessel thermocouple and this total emf is compared with the emf from a secondary or jacket thermocouple. **Electro-Technical Labs, Div., Mandrel Industries Inc.**, P. O. Box 13243, Houston 19, Tex.

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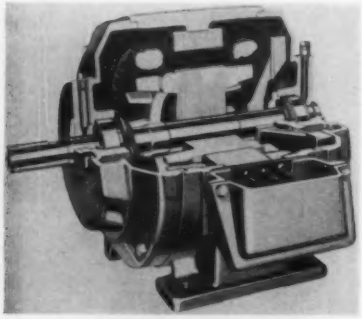

Weatherproof Motor

Line of open weatherproof ac motors features an epoxy encapsulated insulation system. The motors are available in frames 180 through 445 U (1 through 125 hp) in all standard speeds and voltages. The insulation system is built around an epoxy resin which is applied by a vacuum impregnation process. The system uses polyester insulated round copper magnetic coil wire, epoxy-insulated glass fibre sleeving, epoxy-treated glass fibre cloth slot liners, and phase insulation. The stator windings are encapsulated in a specially formulated epoxy resin for resistance to moisture, oils, dust, chemicals, acids, and alkalies. The bearings, exposed internal metal surfaces, hardware, and mechanical parts are protected against damage from the elements and contaminating atmospheres in all types of indoor and outdoor applications. A rust-preventing coating is applied to all internal metal surfaces such as the rotor, stator, and air deflectors. All metal-to-metal fits are greased to keep out contaminants. **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio.

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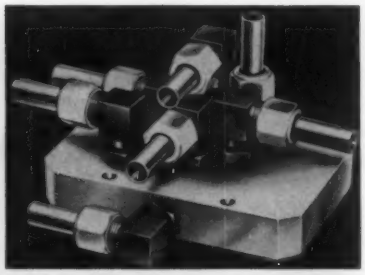

Hydraulic Fitting

Fitting makes a positive metal-to-metal seal, is applicable in hydraulic, pneumatic, lubrication, instrumentation, and other fluid systems. It has straight-thread and consists of a stem and body with a floating nut. Tightening the nut forces the stem to coin its own seat. Body of the fitting does not turn when nut is tightened. Feature of the fitting is a positive leakproof seal without O-rings or special seat preparation. It is available in sizes from ½ to 2 inches OD, in all conventional shapes. **Flodar Corp.**, 16911 St. Clair Ave., Cleveland 10, Ohio.

Circle 429 on Page 19

Tape Transport

Unit is adaptable as a component in magnetic tape recording, and programming for manufacturing control applications. Model 2966 is designed for a 4 inch tape, providing 54 recording tracks. As many as 324,000 bits of information can be stored on a continuous belt of 60 inches. Two methods of advancing the tape can be used and are selected by proper threading. One method advances the tape in increments of ten thousandths of an inch (0.010) on signal command. The other method advances the tape at a steady speed of 10 ips. This speed can be altered to suit a particular application. **Designers for Industry Inc.**, 4241 Fulton Parkway, Cleveland 9, Ohio.

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Solenoid Valve

Unit, designated 1500 Series, is designed for pressures from 0 to 1500 psi and for temperatures from −350 to +450 F. The valve features direct lift action and full-ported construction which insure reliable operation, regardless of pressure drop or flow conditions. The valve is available in bronze or stainless steel, in ¼ to 1 inch pipe sizes. **Atkomatic Valve Co.**, 545 W. Abbott St., Indianapolis, Ind.

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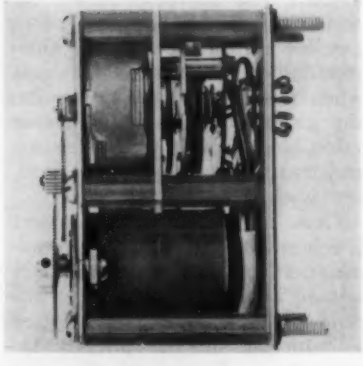

Rotary Stepper

All-magnetic positioning stepper device is designed for precise angular positioning of rotary components such as potentiometers, dials, and indicators. Unit can be coupled to

300 HOUSINGS PER HOUR

produced on Greenlee machine— with assist from VICKERS *hydraulics*

Here's a Greenlee transfer machine that produces 300 steering gear housings per hour while performing a total of 114 close tolerance machining operations. This outstanding performance record is achieved because the machine combines advanced design ideas with the best available components.

Self-contained Vickers hydraulic power packages provide controlled power for clamping the pallet-mounted workpieces in precise position at each work station, driving transfer mechanisms and for movement of certain machine heads. These power packages are designed to JIC (Joint Industry Conference) standards which means easy maintenance and minimum downtime to you.

Vickers offers you power packages, either standard or custom engineered that provide an almost unlimited number of choices to meet your specific technical requirements. You can choose from the broadest product line in the industry any combination of controls for use with single, double, two-pressure or two-stage pumps (the latter for pressures to 2000 psi), and for variable and constant delivery pumps to 5000 psi. Your choice of components will be packaged with the size or shape reservoir best suited for your job.

Whether the Vickers power package you choose is standard or custom engineered, you save money and time because it comes *ready-to-go*—designed and assembled to the highest standard of quality by hydraulic specialists.

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Machinery Hydraulics Division

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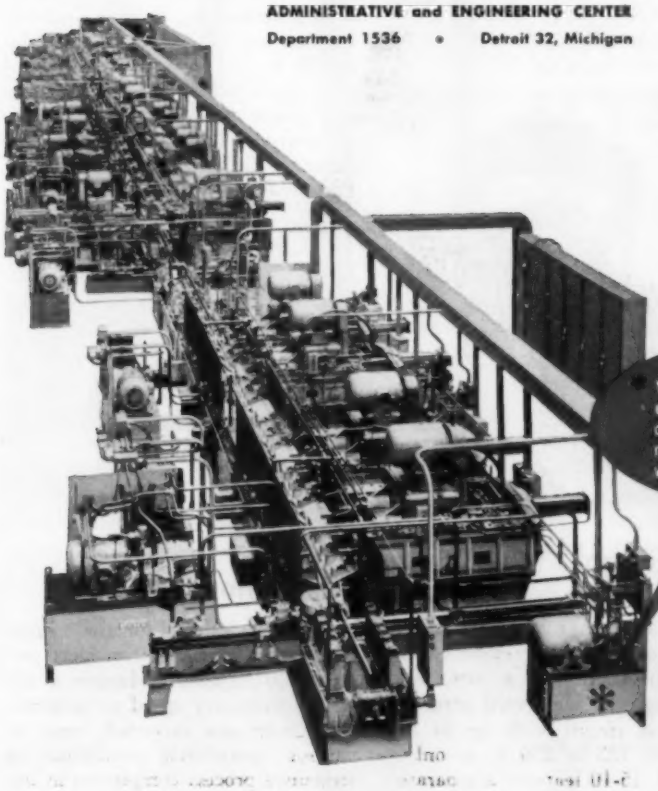
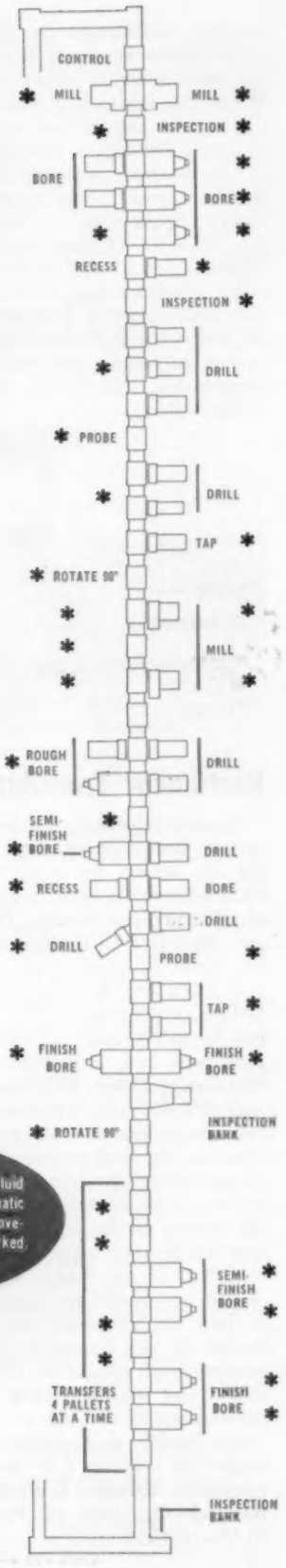
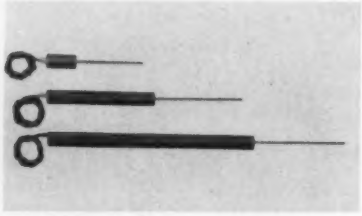


Vickers power packages supply fluid energy for fast, precise, automatic clamping, transfer and head movement at station locations marked with asterisk.



synchro transformers or predetermined pulse counters. It operates on the number of pulses received. When coupled to a synchro transformer, the stepper can be pulsed to rotate through a given number of closed circuit positions, then, on the last pulse, complete an open circuit aligned with the zero angular reference of the transformer. When coupled to predetermined pulse counters, and corresponding switches, the positioning devices can be used to transmit angular information to remote locations. **A. W. Haydon Co.**, 232 N. Elm St., Waterbury, Conn.

Circle 432 on Page 19



Rectilinear Transducers

Electromechanical, variable permeance instruments can be used as position sensors for analytical balances, automatic scale beams, and small meter movements. They are also applicable for the measurement or control of stress, strain, growth, and vibration, and movement of bellows or diaphragms. The ac output is proportional to probe displacement from null position. The transducers (Type ZD) operate as half of a 4-arm ac bridge circuit. A two-arm inductive or resistive device can be used to form the reference half of the bridge. Null position can be shifted as desired by adjustment of the impedance ratio between the two arms of the reference half of the bridge. A center-tapped transformer can also be used to form the reference half of the bridge. In this operation, the null position is not adjustable. The transducers will operate within a temperature range of −65 to +165 F. Three models are available in rated ranges of 0.10 to 0.80 inch displacement. **Crescent Engineering & Research Co.**, 5440 N. Peck Rd., El Monte, Calif.

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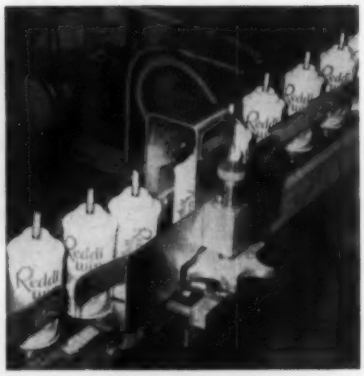
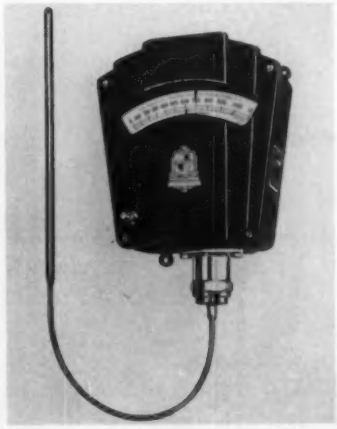


Sideline Code Marker

Device prints a clean, clear impression code mark on either flat or concave bottom bottles and cans. It is constructed of stainless steel and aluminum to meet the requirements of the dairy industry. The marker can be used under wet or dry conditions, is easily accessible for cleaning. Some of the features of the unit are: Self adjusting to line speeds, quick change type holder, and special inking system. **JCL Engineering Co.**, P. O. Box 36004, Wilshire-La Brea Station, Los Angeles 36, Calif.

Circle 434 on Page 19



Limit Control

Designed for temperature limit control, device has a 5 inch scale which provides visual evidence of system operation. As a new feature, it can be connected directly to the line circuit with up to 15 amp loads, 125 or 250 v, ac only. Model HL-15-10 features a separate switch which acts to shut down the system in case of element failure. A setting shaft inside a sealable case can be made inaccessible to unauthorized tampering. Resetting is accomplished by actuating a reset button on the outside of the case. **Partlow Corp.**, 533 Campion Rd., New Hartford, N. Y.

Circle 435 on Page 19

Elapsed Time Indicator

Miniature elapsed time indicator presents three digits, each 1/8 inch high, that can be read at distances up to six feet away. Model 1440 provides readings from 000 to 999 hours with return to 000, in one-hour increments. Overall diameter of the unit is 0.670 inches, and length is 1 7/8 inches. Nominal input requirement is 115 v at 400 cps, single phase. Current is approximately 10 ma. **Bowmar Instrument Corp.**, 8000 Bluffton Rd., Fort Wayne, Ind.

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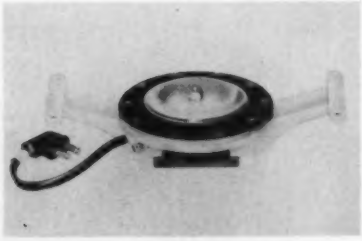
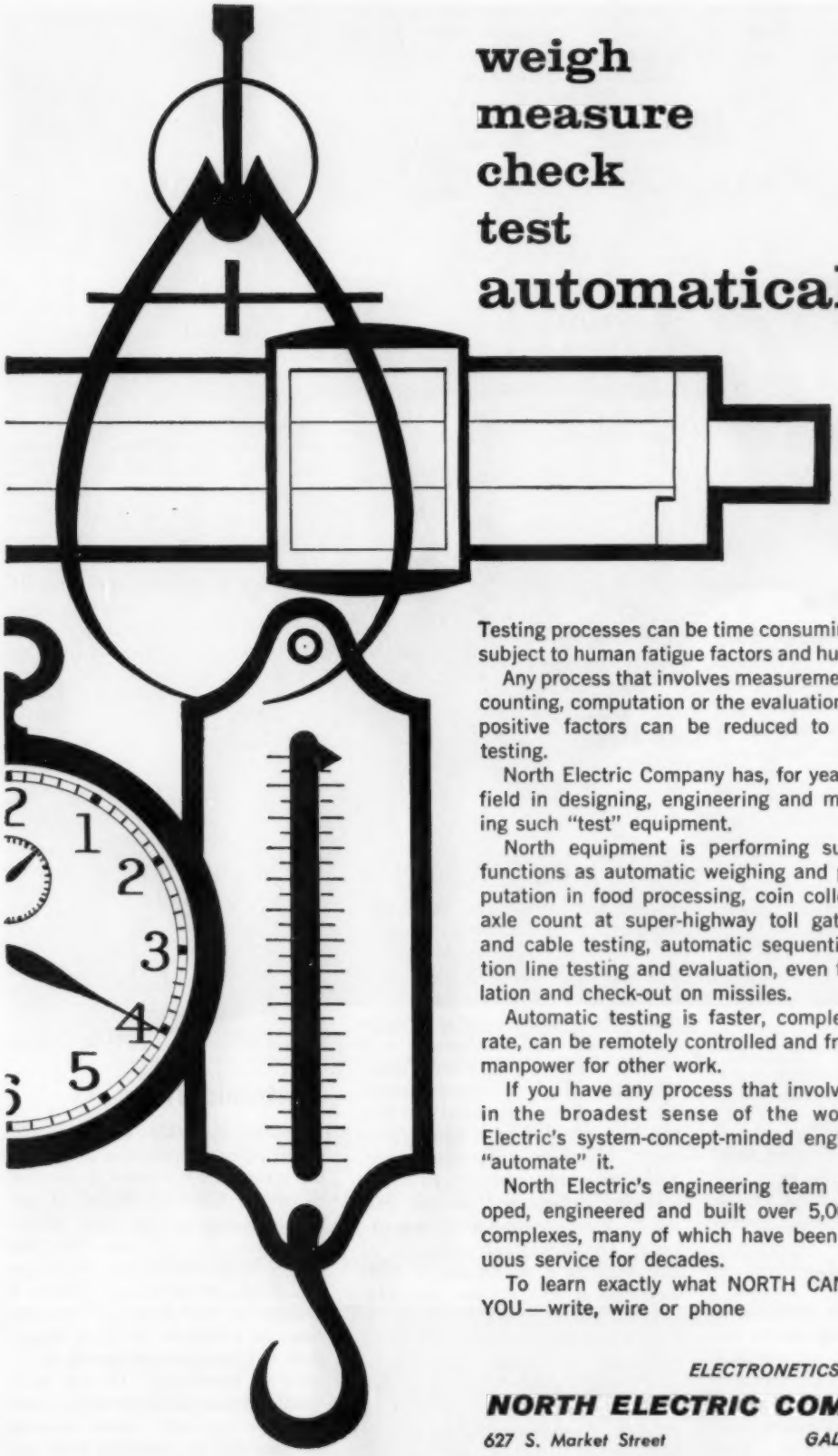


Signal Horn

Device is designed for use in high-level noise areas. It can alert personnel to impending danger, notify when machinery speed or temperature limits are exceeded, warn of various operational conditions, or announce process completion in au-



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Circle 693 on Page 19

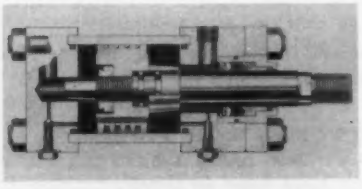
tomatic operations. The vibrating diaphragm of Model PA-37100 is driven by a contactless armature producing an audio output in excess of 105 db at three feet. It operates on 60 cycle circuits. **Wheelock Signals Inc.**, Branchport Rd., Long Branch, N. J.

Circle 437 on Page 19

Tube-Cooled Motor

Air-to-air heat exchanger motor is applicable in the petroleum, chemical, mining, machine tool, and pulp and paper industries. The motors, available in sizes ranging up to 2000 hp, are constructed to provide protection against excessive moisture, oil vapor, chemicals, alkalies, coolant, and air-borne dust, sand, dirt, and metallic particles. Other features of the unit include: Capsule type split sleeve bearings and pressure lubricating systems with oil level indicators. **Louis Allis Co.**, Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

Circle 438 on Page 19



Hydraulic Cylinder

Feature of hydraulic cylinder is a cartridge rod bearing which incorporates a metal rod scraper plus a rubber rod wiper. This provides a two-fold protection against chips and dirt which tend to enter cylinders and damage them. The cartridge rod bearing can be removed without removing the cylinder from its mount and without disassembling the cylinder. The bearing incorporates spring loaded multiple vee packings that compensate for wear. A self-centering floating cushion is used to compensate for high side loads which can cause excessive rod bearing wear. The cushion will concentrically align itself with the cushion cavity in the front head. Tie rods and piston rods are of high carbon steel, furnace treated with a minimum yield strength of 100,000 psi. The cushion needle and ball check are flush mounted, are interchangeable, and are adjustable and positively locked in position. **Carter Controls Inc.**, 2977 Bernice Rd., Lansing, Ill.

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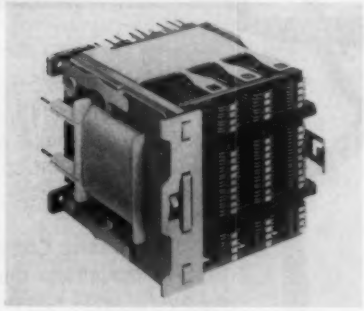

Wire-Spring Relay

Unit can transfer up to 51 circuits. It features an actuating card, activated by armature movement, that operates all moving wire-spring contacts simultaneously and independently. The moveable springs are aligned and anchored in a molded assembly. A plastic comb aligns the relay's stationary springs. The entire level of stationary springs can be controlled by simple adjustment of their supporting arm. Solderless-wrap terminals eliminate soldering defects and provide gas-tight, corrosion-resistant connections. The insulation resistance of the relay is a minimum of 1500 megohms at 80 F, 88 per cent relative humidity. Model WQA is available in one, two, or three levels of contact assemblies, with up to 17 Form C combinations, each. Operating voltages range from 6 to 220 v dc. **Automatic Electric**, Northlake, Ill.

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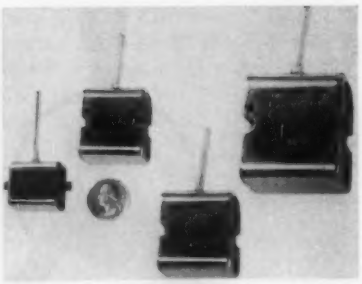

Torque Motors

Line of small displacement electromechanical actuators is available in four styles, with strokes ranging from ±0.006 to ±0.015 inch. Hysteresis is 2 per cent, with resonant frequency of four styles ranging from 400 to 940 cps. The unitized construction contains and affixes pole pieces, magnets, and armature to a non-magnetic stainless steel frame and eliminates problems such as pole pieces or magnets shifting position or breaking away from the assembly in either shock or vibration. **Servotronics Inc.**, 190 Gruner Rd., Buffalo 25, N. Y.

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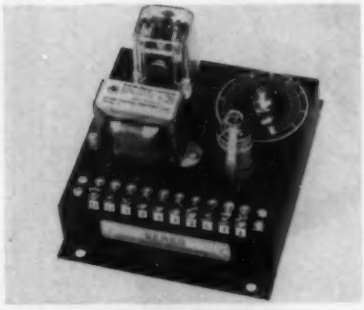

Electronic Timer

Device, available with two different types of operation, is applicable where a time delay is required in circuit function. Model D performs a time delay after de-energization, is available in time ranges from 0.06 seconds minimum to 2.3 minutes maximum. Model E performs a time delay on energization, is available in time ranges from 0.05 seconds minimum to 2.4 minutes maximum. Double pole, double throw, two normally open and two normally closed contacts are provided as standard with ratings of 5 amp, 115 v ac, and 5 amp,

Ajax Magnethermic supplies all types of Induction Melting Furnaces including: core, coreless, lift and automatic pouring. Vacuum melting and degassing applications are among their many uses. 60 cycle, motor generator, mercury arc converters, R. F. generators and the new 180 cycle Multiductor, all products of AM, are available as the power source.

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3990 Simon Road
Youngstown 1, Ohio

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28 v dc. A supply voltage of either 115 v or 230 v, 60 cycles can be used. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.

Circle 442 on Page 19

Miniature Agitator

Explosionproof agitator was designed for use in laboratories carrying out color control work, but it is also adaptable for use with automatic or hand guns, fitted to paint cups, or extremely small containers, or held in the hand for use in places where a standard mixer cannot be used. Model 5518 is not subject to damage by stalling or overloading, and is capable of speed variation as required. A special model, mounted in a four-ounce jar, has been developed for use in the electronics field for the agitation of critical ceramic and metallic materials used in the manufacture of cathodes and transistors. **Spraymation Inc.**, 25 Amity St., Little Falls, N. J.

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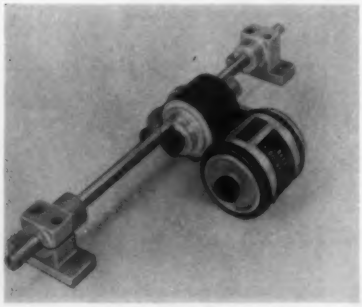
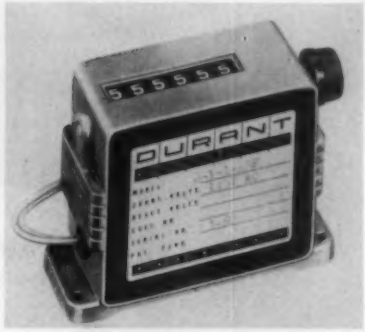


Two-Roller Coder

Adaptable for installation on any packaging machine or conveyor, coding unit can imprint on plastic, cardboard, fiber, glass, metal, and paper containers or wrappers. The printing roller can be fitted with either rubber or metal type. When the proper inks are used, it will imprint on almost any packaging material. Model 1019 consists of an ink roller which transfers directly to a printing roller. It has a 10-inch printing wheel circumference with a 2-inch face width. The ink roller assembly can be easily removed. It can also receive additional ink while the unit is in operation. Adjustment of the roller arm screws switches the coder from right hand to left hand operation. **Bell-Mark Corp.**, 18 Ropes Place, Newark, N. J.

Circle 444 on Page 19



Electric Counter

Applicable for counting operations at high, medium, or low speeds, Model 6-Y-1-RMF can be mounted directly on production machinery, or it can be activated by a contactor and panel mounted away from the machine. It has a life rating of 30,000,000 counts at a speed of 1000 counts per minute, with operating speeds up to 1200 counts per minute at normal voltage. Feature of the unit is a fast operating solenoid, with a compact built-in rectifier for ac operation. The solenoid operation escapement mechanism has only one moving part, in addition to the number wheels and reset shaft. The counter is made of corrosion resistant material, and is housed on a one-piece die cast frame. It is unaffected by shocks and vibrations, and will not produce extra counts when jolted. **Durant Mfg. Co.**, 1997 N. Buffum St., Milwaukee 1, Wis.

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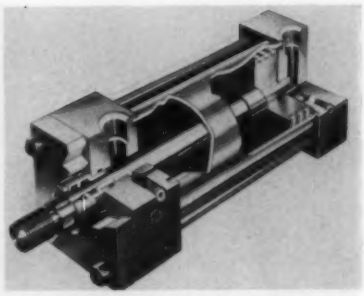

Hydraulic Cylinder

Line of power cylinders, available in bore sizes from 1 inch through 8 inches, is designed to operate at full 1000 psi hydraulic pressure. The cylinder has a square head and tie rod design, with case hardened and hard chromium plated piston rods. Features of the unit are drip-free rods and leak-proof ports. Fourteen different mountings are available. **Power Cylinder Div., Hannifin Co.**, Dept. 142, 501 S. Wolf Rd., Des Plaines, Ill.

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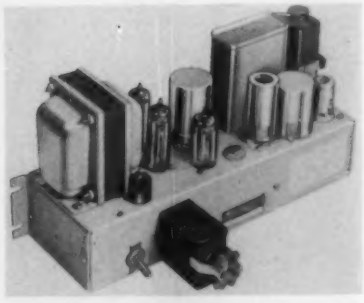

Servo Amplifier

Applicable for industrial process control systems, servo amplifier is adaptable to any type of control instrumentation or automation where the transducer produces a change in voltage or resistance representative of the measured variable. The amplifier is sensitive to a 3 mu v change in input signal, with ±2 mu v stability. It is a high-gain, dc to ac amplifier which recognizes the polarity of a low-level dc input signal, converts it to ac, and amplifies it sufficiently to drive a servo motor in accordance with that polarity. Unit contains a fail-safe circuit to protect the system in which it is used against an open input circuit or failure of

any critical amplifier component. Operating power supply is 117 v, ±10 v; 50-60 cps. **Thermo Electric Co. Inc.**, Saddle Brook, N. J.

Circle 447 on Page 19

Digital Voltmeter

Four-digit instrument automatically measures the absolute rms voltage over a frequency range from dc through 5 kc. Model 800 incorporates a temperature stabilized diode network, operating on the square law principle, to yield a true rms voltage reading regardless of the ac waveform or dc. Voltmeter features 0.1 per cent accuracy for crest factors up to 2; 0.1 per cent response from dc through 5 kc; calibration accuracy held for a minimum of 30 days; automatic ranging; and binary coded decimal and decimal outputs. Range is 1 v to 999.9 v, with manually selected 0.1 v to 1 v range. Balance time is typically less than 3 seconds; maximum 5 seconds per range. **Electro Instruments Inc.**, 3540 Aero Court, San Diego 11, Calif.

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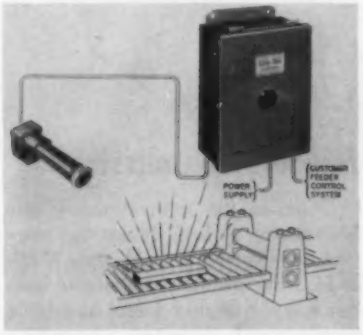

Detector Control

Infrared detector control detects infrared radiation in the visible spectrum and short wave length range (7000-9500 angstroms) from radiating sources. It is used in the detection of hot ingots, blooms, billets, slabs, and other radiant sources found in steel mills and similar industries. When the device detects the presence of radiating bodies, it can produce a signal to initiate the sequential operation of systems such as water descalers, hydro jet descalers, colloidal graphite spray systems, roll cooling systems, roll spray quenching systems, transfer operations, coil upenders, and bar turnover mechanisms. It can also be used to initiate slow down and final stop operations, to signal looper controls, and to give impulses to counter controls.

The infrared sensing head is located at a distance from and aimed at the radiating source to be detected. Connections are made between the sensing head and the control panel. Infrared radiation is detected by the sensing head and transformed into an electric signal, which operates the relay in the

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Here is a combination that feeds tubing and bar stock — automatically — to a fast, automatic cutting-off machine. Best of all, the pieces being cut off can be formed, grooved, flanged or chamfered at the same time.

There are models that handle tubing, pipe and bar stock from ⅛" diameter up to solid bar stock of 3" OD and tubing up to 8" OD.

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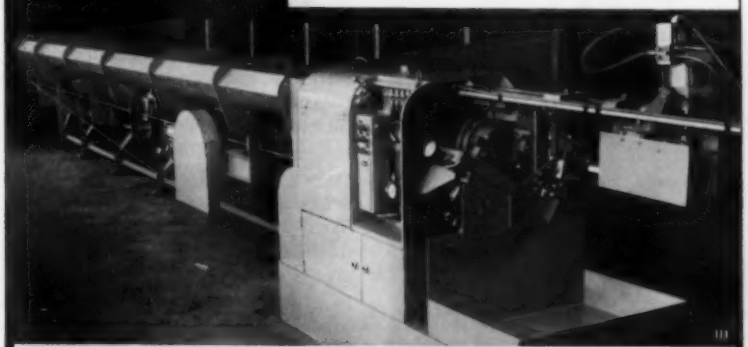

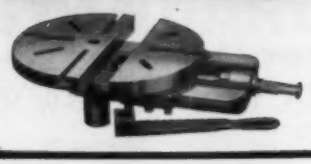

FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.

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control panel. When the source of radiation is no longer in the sensing area, the relay is de-energized. All hot objects emit an infrared radiation that travels in a straight line and is not absorbed by the surrounding air. **Euclid Electric & Mfg. Co.**, Madison, Ohio.

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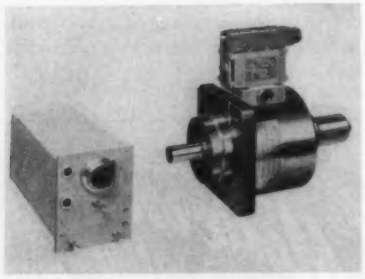
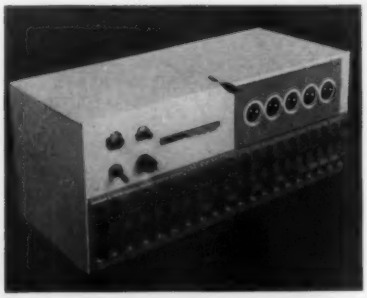


Variable Speed Drive

Variable speed servo drive system can drive in the zero speed region where speed regulation, no load to full load, and long term speed stability are typically of the order of 0.1 rpm. With a higher available torque, the drive can be directly coupled to loads such as machine tool lead screws without intermediate gear reduction. The no-load to full-load regulation at the high end of the speed range is approximately 0.2 per cent, and the actual speed will be within 1 per cent of the setting on the speed control dial. **Pegasus Laboratories Inc.**, 3690 Eleven Mile Rd., Berkley, Mich.

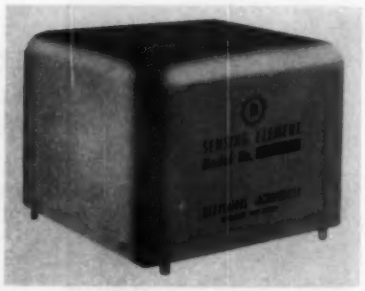
Circle 450 on Page 19



Timing System

Device is applicable in range timing systems, time correlation of test data in major test programs, and central programming units. Heart of the system is a time correlation unit which consists of a time indicator, frequency divider, and time accumulator. The time correlation unit permits the timing system to function as an electronic clock in military time of hours, minutes, and seconds or as a total elapsed time accumulator through choice of plug-in logic modules. System is designed to drive up to three remote time indicators. The serial time word readout is also flexible and can include timing markers, amplitude coding, amplitude modulated carrier, or pulse width modulation. **Temco Electronics, Div., Temco Aircraft Corp.**, P. O. Box 6191, Dallas 22, Tex.

Circle 451 on Page 19



Signal Converter

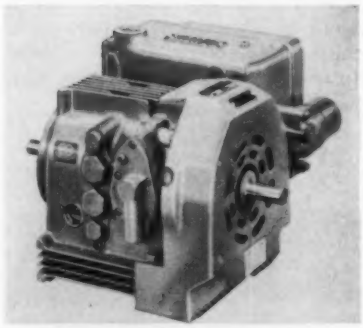
Device is applicable for process control, motor speed control, generator and alternator voltage control, alternator frequency control, and oven-temperature control. It can convert various measured variables to a dc signal suitable for comparison with all common dc reference voltages, such as zener diodes, standard cells, and glow-tubes. The measured variables include: Alternating voltage or current, speed, dc, temperature, and frequency. Accuracy ranges from ± 3 to ± 5 per cent, stability is ± 0.1 per cent. With appropriate transducers, the module can convert pressure, force, acceleration, humidity, ph, and flow to a dc voltage. Illustration shows Model SXAR-1, a single-phase rms-to-dc converter. It is rated for: Input, 0-1/10/40/160/320 v rms; output, 1.0 v dc full scale; accuracy ± 5 per cent; stability ± 0.1 per cent. **Regulators Inc.**, 455 W. Main St., Wyckoff, N. J.

Circle 452 on Page 19

Photoelectric Controls

Line of transistorized, tubeless photoelectric controls is available with two types of controls: *On-Off* and time delay. Unit includes transistors, photoconductors, printed circuits, and miniaturized light sources and receivers. Forward and reverse circuits are available in each control by a simple adjustment on the terminal board. The flip-flop action of the circuitry eliminates relay chattering problems. The light sources and receivers are available in either end-view or side-view configurations. **Photoswitch Div., Electronics Corp. of America**, One Memorial Dr., Cambridge, Mass.

Circle 453 on Page 19



Midget Transmission

Designed for applications of one horsepower or less, device can convert any constant speed input power into an infinitely adjustable output speed. One or more adjustable speeds can be selected (depending on the choice of integral control devices) in one or both directions up to 1650 rpm. Integral with this unit is a gear pump for supercharge, control, and auxiliary serv-

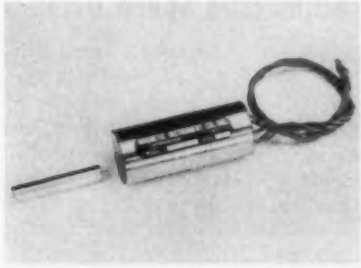
ice; a cooling fan; a fluid reservoir case; and overload relief valves. Input speed is 1750 rpm, output speed variable up to 1650 rpm. Starting torque is 62 lb-in., normal torque 45 lb-in., peak torque 67 lb-in. **Oilgear Co.**, 1571A W. Pierce St., Milwaukee 4, Wis.

Circle 454 on Page 19

Magnetic Storage Drum

Magnetic storage drum has 250 tracks, 460,800 bit capacity, and 3072 bits per track. Standard operating parameters include bit repetition rates (return to bias) of over 300 kc and (non-return to bias) over 600 kc. Speed range for Model 7508 is 900 to 6000 rpm. Runout is less than 0.0001 inch T.I.R. **Bryant Computer Products Div.**, P. O. Box 620, Springfield, Vt.

Circle 455 on Page 19



Differential Transformer

Linear variable differential transformer is used for the measurement or sensing of linear motion. It can operate nominally from 6.3 v, 60 cycles and have a sensitivity of 10 v per inch at rated excitation. The range of Model 360-1 is ±0.15

Save up to ⅓ on the cost of your next conveyor...new handbook shows how

Tells how to cut planning and installation costs with pre-engineered, ready-built conveyor components for immediate or future handling needs

Install a conveyor system to meet your specific materials handling needs today . . . tomorrow . . . or in years to come. Using Standard's Handidrive handbook, simply order pre-engineered, prebuilt interchangeable conveyor components to which additions or alterations can be made as required.

"Do-it-yourself" buyer-users will find Handidrive assembly is fast, easy. The pre-engineered stock units include: roller conveyors (either gravity push-along or live roller type), inclined belt conveyors, drive units, intermediate sections, curved sections, supports, hangers and other miscellaneous items.

Lower initial cost — you buy only what you need — is only one of many Handidrive "off-the-shelf" benefits. The Handidrive handbook gives full details! Get your copy now . . . free of charge, of course.

3 plans to help you select and order simplified HANDIDRIVE pre-engineered units

"Do-It-Yourself" Plan — Determine your conveyor requirements, then select stock units from Handidrive handbook.

"Recommendations-Requested" Plan — On your request, a Standard specialist will advise you on installation of a custom-tailored Handidrive conveyor

"Leave-It-All-To-Standard" Plan — Standard's staff of experienced engineers will work out your handling problems of a more complex nature.

STANDARD
GRAVITY & POWER CONVEYORS
Sales and Service in Principal Cities
OVER 50 YEARS
of conveyor experience

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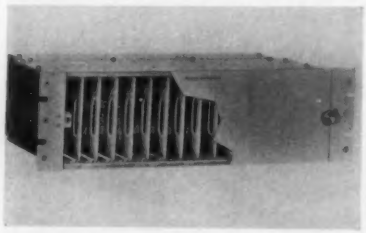
North St. Paul 9, Minn., Dept. EE-7
Please send me a free copy of your new Handidrive handbook.

Name.....
Company.....
Address.....
City.....Zone.....State.....

Circle 696 on Page 19

inch with linearity stated at 0.25 per cent or better. It can operate over temperature ranges of from −60 to +220 F. The transformer consists of a primary winding and two secondary windings spaced axially along an encapsulated bobbin. The core is a magnetic rod free to move axially within the bore of the device. **Magnetic Instruments Co. Inc.**, 546 Commerce St., Thornwood, N. Y.

Circle 456 on Page 19



Transistor Switching Unit

Instrument can accept up to 100 different *On-Off* signals in a broad range of voltages and pulse shapes. Within 100 microseconds, it will graphically display the signal condition on a direct writing sequence recorder. Unit, designated Trans-Switcher, contains ten decade boards with each one capable of handling 10 signals in a wide range of voltages and pulse shapes. The decade boards are plug-in units, which are replaceable. It is designed to work with company's operations monitor which records 100 events electrically on a moving chart 12 inches wide. *On-Off* input data appear on the chart and provide a record of events, their duration, and time relationship to each other. **Brush Instruments, Div., Clevite Corp.**, 37th & Perkins, Cleveland 14, Ohio.

Circle 457 on Page 19

Position Encoder

Model C-804 provides an output of 3600 quanta per revolution in Datex code or 4096 quanta per revolution in Gray code. It is capable of unlimited readout cycles, with the sampling rate limited only by the readout device. Encoder uses brush contacts to give high current carrying capabilities. The brushes are of precious metal alloys and are designed to maintain the original performance despite wear. The etched discs are plated for low contact resistance and for protection

against corrosion. Readout is obtained by the application of a suitable low current voltage to the contacts. Since the brushes are always in contact with the disc, readout can be obtained while the encoder is in motion. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 458 on Page 19

Step-up Production Line EFFICIENCY

Systems are available with speed reducing or increasing gears—with 12- or 24-hour disc charts or with 31-day strip-type charts.

with Wagner-Sangamo industrial Tachographs

Use these precision recording devices anywhere that the control of speed, time and measurement is essential to the quality of your products. They tell you how fast and long a machine is used . . . let you measure output versus time . . . fit in perfectly with quality control and time study programs . . . graphically record operation of one machine or entire automated line to help you determine production peaks and valleys, and non-productive time.

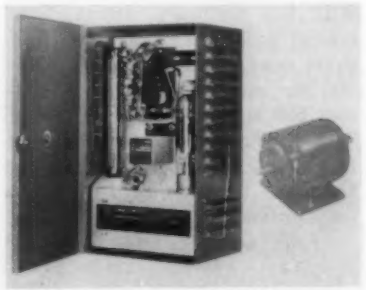
Consult your nearby Wagner Sales Engineer, or write us about your production recording problem. Wagner engineers will tell you if Tachographs will help you increase production efficiency.

W160-1

Wagner Electric Corporation

6430 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

Circle 697 on Page 19



Adjustable Speed Drive

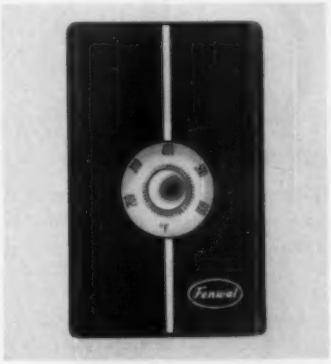
Feature of adjustable speed drive is a sensitive static feedback control which can automatically be reset to follow an unlimited number of input signals to change speed or mode of operation. Speed changes, acceleration, deceleration, precision slow-down, precision shaft rotation stop, and dynamic braking and reversing are easily sequenced. The motor-drive achieves its performance by use of a VecTrol thyratron phase shifting grid control which provides failsafe regulation of the output of a single thyratron from zero to maximum with a dc control signal of only a fraction of a volt. Regulation ranging from 1 to 2 per cent is obtained. Drives

are available with ratings from 1/40 to 3 hp. **ECI Mfg. Div., Electronic Controls Inc.**, 85 Magee Ave., Stamford, Conn.

Circle 459 on Page 19

Temperature Control

Transistorized temperature controller covers a temperature range from −50 to 600 F, with a sensitivity of 0.3 F and current handling capacities of 10 amps, 110 v ac, and 5 amps, 230 v ac. Model 536 is a



single point controller, with either *On-Off* or proportioning action. The set point can be adjusted by a potentiometer located within the case, on the front cover, or remotely. Feature of the controller is an optional indicator circuit. This permits the unit to both indicate and control simultaneously, with a single sensor, without any interaction between the two functions. When this unit is adapted for indication, it can be used with a Model 580 indicator, and can handle one to ten controllers. When used with several controllers, it has a selector switch by which the point to be indicated can be identified. A spring loaded button switch enables the meter to display the controller set point of that point. **Monitor & Controls Div., Fenwal Inc.**, Pleasant Street, Ashland, Mass.

Circle 460 on Page 19

Magnetic Amplifier

Unit features a null stability of 28 mu v or less over a temperature environment of −40 to +85 C. With thermocouple, strain gage, photocell, or other low level inputs,

with **LIPE**
Automatic Machine Loading

● You can meet and beat competition by getting peak production from every machine in your shop — new *and* old. Lipe Automatic Machine Loading delivers at least 90% of the gross geared capacity of any production machine, because stock is fed continuously. Your machines cut stock — not air!

● Lipe AML Bar Feeds automatically feed stock of practically every length, shape and material, in close-tolerance feedouts. Users report production increases of 40% . . . 90% . . . and even 200% per machine, plus labor benefits that are even more important. Workers are freed from back-breaking hand-loading of stock . . . concentrate on quality and machine set-ups. For a free estimate of what Lipe AML can do for your shop, send prints or samples of typical work. Write for full information.

Stop Cutting Air and You Start Cutting Costs

Lipe-ROLLWAY
CORPORATION
SYRACUSE 1, N. Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 698 on Page 19

AIR-HYDRAULICS

DOUBLE ACTING • ADJUSTABLE AIR PRESSES

PRECISION HONED WITH CUSHIONED CYLINDERS TWO FAST ACTING MODELS

For fast and steady small assembly work • riveting • punching • marking • staking. Equalized ram pressure in excess of 1 ton and ½ ton from 90 pound line. Double action gives lifting power almost matching ram pressure. Maintenance reduced by using "O" ring seals and bronze ram bushings. Head fully adjusts for proper stroke length and accurate die-setting. Extra heavy ram guide.

FOR LOW COST APPLICATION TO YOUR JOB—WRITE

AIR-HYDRAULICS

CUSHIONED STOP . . . FOR ACCURATE INDEX

HERE'S YOUR ANSWER, if accuracy and dependability are important to you. Cushioned stop eases work to position. Locking cylinder stops the table "on the money" and holds it until released by locking dog. Changes in loads, diameters or speeds are no problem either, since both speed and cushion are adjustable. Top plate is 15" in diameter but the rugged mechanism will handle much larger work loads. Table will make up to 100 indexes per minute with a 22" diameter, 200 lb. load.

OPERATES on 60-175 lbs. pressure when equipped for air but table is available for either air or hydraulic operation. 4, 6, 8, or 12 stations are standard but others, up to 30, are made to order.

REPRESENTATIVES:
SOME TERRITORIES STILL OPEN.
WRITE FOR INFORMATION.

AIR-HYDRAULICS

299 HUPP AVENUE

JACKSON, MICHIGAN

Circle 699 on Page 19

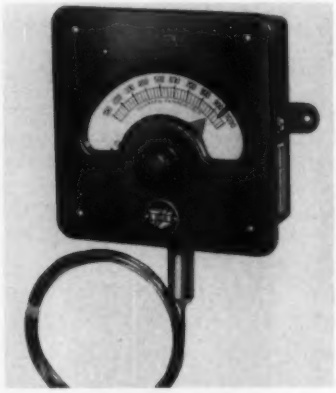
the 400 cps amplifier can deliver 0 to ±5 v output into a 50 k ohm load at accuracies of 0.1 per cent in a single stage of amplification. It is applicable for linear amplification, null and error detection, summing with electrical isolation, integrating, and micro volt and microampere measurement. Other features of the unit include: Built-in temperature compensation, a filtered output, and inherent high gain and reliability. **Seminole Div., Airpax Electronics Inc.**, Fort Lauderdale, Fla.

Circle 461 on Page 19

Sensor & Switch Unit

Noncontact sensing and switching system consists of two sensors and a control unit. Using ultrasonic energy for its beam, it is applicable for counting, sorting, routing, machine safeguard, plant protection, door control, and hopper and bin level control. The instrument can sense liquids, solids, ferrous and nonferrous metals, opaque, or transparent objects. The sensors can be completely concealed or remotely located. Operation is not affected by ambient light, dust, mist, or a normal build-up of residual solids on the face of the acoustic lens. They can operate in temperatures of +220 to −100 F. **Electro-Sonics Div., Delavan Mfg. Co.**, West Des Moines, Iowa.

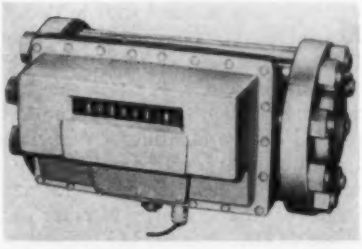
Circle 462 on Page 19



Temperature Control

Remote bulb, high temperature indicating temperature control will operate over a range from 100 to 1000 F. A single scale with two pointers provides an easy reference between the setting and controlling temperatures. Thermal assemblies for Model E36N can be replaced in the field. Switching actions available include: Normally closed, normally open, and double throw. Ratings are 15 or 20 amp, 115/230 v ac. Snap-action switches are single pole and suitable for up to 180 F ambient temperatures. **United Electric Controls Co.**, 85 School St., Watertown 72, Mass.

Circle 463 on Page 19

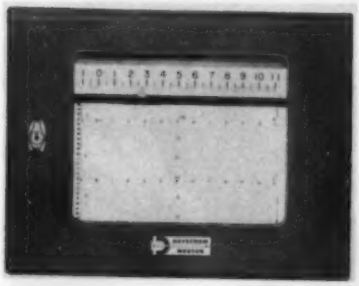


Mass Flowmeter

Flowmeter for natural gas makes possible the measurement of gas directly in pounds, requires no in-between calculations. Feature of the instrument is a sensing device that consists of a constant speed impeller and a stationary turbine arranged for axial flow. The impeller gives a twist to the fluid stream and the fixed turbine

straightens the stream. The torque exerted on the turbine is proportional to the mass rate of flow. A small gyroscope automatically totalizes the flow by integrating the torque with respect to time, permitting the output to be continuously summed up on a dial reading in pounds. The flowmeter can be designed into remote controlled systems. Electrical pulses, each representing a given rate of flow, will operate remote-recording dispatching and accounting systems. **Black, Sivalls, & Bryson Inc.**, 7500 East Twelfth St., Kansas City 26, Mo.

Circle 464 on Page 19



Peak Height Recorder

Instrument is designed for process gas chromatography or other measurements where peak height of individual stream components is important in indicating concentrations. Model 6707 records peak heights only, printing them as successively numbered points on a slowly moving chart. The recorder is equipped with one set of input terminals and a multipoint printing head. Each unit impulse drives the pointer upscale, but no printing is done until an electronic detector senses the peak signal. The detector then activates the printing head and advances the head to the next number. Because of the slow chart speed and the condensed data recorded, hours of stream analysis can be studied in the recorder window at any given time. Special features are available for safeguarding against false or secondary peaks, providing for disappearing components, and periodically synchronizing the peak picker with the chromatograph. **Weston Instruments Div., Daystrom Inc.**, 614 Frelinghuysen Ave., Newark 12, N. J.

Circle 465 on Page 19

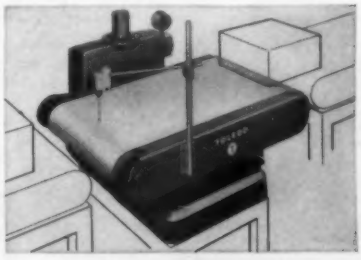
TOLEDO Reports on Automatic Weighing

★ *NEW IDEAS FOR COST-SAVING*

Chance of human error is eliminated in this Toledo system. Each formula is preset on a "Batchboard". The control panel can be located as desired in relation to the scales.

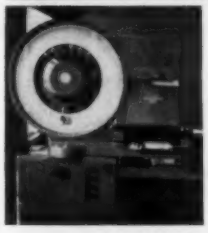
AUTOMATIC BATCHING

Operator at convenient remote location has full command of a multiple scale batching system with Toledo Remocon. As many formulas as required are pre-set on "Batchboards" and inserted into panel. This is one of several types of Toledo remote-control batching systems for today's needs, including punch card, "Formulaplug" and digital scanner. Ask for Bulletin 2964.



CHECKWEIGHS IN-MOTION

Many plants today are putting Toledo Automatic Checkweighers into their conveyor lines. Models to provide continuous, 100% in-line checkweighing of items from a few ounces to 200 pounds. Motorized belt. Handle sacks, cartons, packages, pieces, parts. Ask for Bulletin 2968.



LOAD CELL DIAL DOES TRIPLE DUTY

. . . ALSO PRINTWEIGH RECORDING

One remote dial serves *three* platforms in this Toledo Electronic Load Cell Scale for truck weighing at a large cement plant. With a truck on three platforms, scale reads individual axle loads or total weight. Equipped with Printweigh "400" to print full figure weight data. Brings new versatility to weighing. Request Bulletin 2970.

AUTOMATES DRUM-FILLING

In this oil industry plant, a Toledo sub-surface filler automatically eliminates foaming and controls drum filling. The scale is keyed into conveyorized system . . . provides faster, more accurate filling. Saves time, labor, avoids loss of material and customer goodwill. One of many operations where Toledo controls guard costs. Ask for Bulletin 9030.

●

WRITE TODAY for specialized help from our Custom Products Division, or contact the Toledo Office near you, to solve your problems in batching, checkweighing, drum-filling, load cell applications. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.

(Toledo Scale Co. of Canada, Ltd., Windsor, Ont.)

SERVICE Factory-Trained 360 Cities

TOLEDO®

Headquarters for Weighing Systems

Circle 700 on Page 19

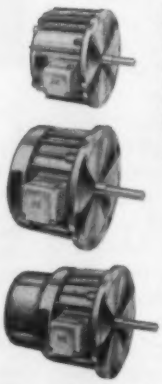
"Molded Horsepower" to fit your machine tool

...no longer must you "make something do!"

Just as a famous artist molds each illustration to his need... so, too, can you now have a machine tool motor designed for machine tool use. Not just another line of motors that can be "made to fit," but a complete new type developed, by Reuland, exclusively for machine tool manufacturers.

Reuland "Molded Horsepower" offers a combination of advantages never before available. Dynamic balancing, low inertia rotors, heavy duty ball bearings straddling the rotor, compact "wafer" design, smooth finished castings, baked enamel finishes... even pleasing lines that can be varied to fit the contour of *your* machine!

No wonder Reuland is "number one" supplier to many of the top names in the machine tool field!



Reuland Precision Machine Tool Motors are available in totally enclosed non-ventilated or fan cooled types – ratings from ½ h.p. through 15 h.p. Also available as a machine tool *brakemotor*, incorporating both motor and Reuland magnetic brake in a single frame.

Our new 8-page catalog, No. GS8-30-0, will come in handy. Sent complete with prices and engineering drawings on request.

Refer to Sweet's Product Design, Section 5-a

MODERN POWER FOR MODERN-DAY PRODUCTS

... all in lightweight, cool-running aluminum frames!

REULAND MOTORS

REULAND ELECTRIC COMPANY
WESTERN DIVISION: *Alhambra, Calif.*
EASTERN DIVISION: *Howell, Mich.*
Distributors in all principal cities

Circle 701 on Page 19

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 19.

Amplistats

General Electric Co., Schenectady 5, N. Y.—20 *page booklet*—Line of amplistats (1 volt-ampere to 100 kva) described in Bulletin GEA-6930 can be used to amplify signals from sources such as thermocouples, strain gages, thermistors, photocells, phototube amplifiers, and transistor amplifiers. Types of amplistats covered include: General purpose toroidal core amplistats and amplistat reactors, static control amplistats, process (temperature) control amplistats, and motor drive amplistat reactors. Outline diagrams and wiring diagrams are given, and charts show operating curves.

Circle 466 on Page 19

Hydraulic Milling Machine

Kent-Owens Machine Co., 958 Wall St., Toledo 10, Ohio—8 *page bulletin*—Subject of bulletin is Model 3-36, a hydraulic milling machine that has a table with an infinitely adjustable feed rate of ½ to 60 ipm, and a rapid traverse rate of 300 ipm in either direction. Both conventional and climb milling performance features are pointed out. Diagrams and floor plan drawings are also included.

Circle 467 on Page 19

System Building Blocks

Digital Equipment Corp., Maynard, Mass.—6 *page pamphlet*—Descriptions are given in Bulletin C-4000 on 500-kilocycle, plug-in, system building blocks. Units covered include: Single, dual, and quadruple flip-flops, inverters, pulse generators, delays, pulse amplifiers, clocks, binary to octal decoder, and level and intensity amplifiers. An explanation is given of the logical characteristics of the plug-in units, aided by graphic illustrations.

Circle 468 on Page 19

Potentiometer Transducers

H. E. Sostman & Co., 454 E. Lincoln Ave., Cranford, N. J.—4 *page pamphlet*—Data are given in bulletin on potentiometer transducers as applied to pressure, motion, altitude, weight, flow, indicating, recording systems, and controlling. Seven transducers are described, with features for the different units given.

Circle 469 on Page 19

Tape Controlled Machining

Kearney & Trecker Corp., 6784 W. National Ave., Milwaukee 14, Wis.—16 *page booklet*—Booklet AP-60 entitled "Around a Part in Just 8 Days" describes the step-by-step method for processing a part on a tape controlled Milwaukee-Matic system. Photos show the procedure from blueprint to finished machined part in only 8 working days. Suggestions are given on what to consider when planning for manufacturing. Comparisons are made between a Milwaukee-Matic system and a conventional system process flow.

Circle 470 on Page 19

Parts Assembler

USI Robodyne, Div., U. S. Industries Inc., Silver Spring, Md.—6 *page pamphlet*—Device, designated TransfeRobot, is the subject of booklet. It is an automatic parts assembler, machine operator, and production hand. Details are given on the basic components which are: An electromechanical arm, a many-fingered hand, and an electronic control system. The means of programming and setup which permits it to be switched from job to job in one-half hour are also explained.

Circle 471 on Page 19

Secondary Unit Substations

Pennsylvania Transformer Div., McGraw-Edison Co., Canonsburg, Pa.—24 *page catalog*—Bulletin PSG-6001 contains ratings, weights, and dimensions for planning low-voltage substations for secondary distribution systems. Types of load centers and substations are described for both indoor and outdoor applications. Specifications are included for incoming supply sections, transformer sections, and outgoing feeder assemblies, both indoor and outdoor.

Circle 472 on Page 19

Slide Assemblies

Russell T. Gilman Inc., 623 Beech St., Grafton, Wis.—24 *page catalog*—Data are given in Catalog 1000 on nine major types of slide assemblies, available in 123 standard models and sizes. Stroke lengths range from ¾ to 8 inches and table areas from 2 by 3 inches to 8 by 24 inches. Instructions are given for designing standard slide assemblies into special or semispecial production equipment for straight-line precision movements. Dimensional drawings and full-size end section tracing templates are also included.

Circle 473 on Page 19

Contact Meter-Relays

Assembly Products Inc., 75 Wilson Mills Rd., Chesterland, Ohio—20 *page booklet*—Meter-relays, used to indicate, monitor, and control any variable that can be measured electrically, are described in Catalog 4-H. Operation of the meter-relay is explained, and details are given on the circuitry, aided by diagrams. Ordering information is also included.

Circle 474 on Page 19

Magnetic Particle Clutches

Electro-Mechanical Div., Lear Inc., Box 688, 110 Ionia Ave. N.W., Grand Rapids, Mich.—16 *page booklet*—Line of magnetic particle clutches described in Bulletin GR-324 ranges in capacity from 2.5 oz-in. to 1900 lb-in. Principle of operation is explained, aided by charts showing performance curves. Installation drawings showing the application of the 10 different series of clutches are also given.

Circle 475 on Page 19

Pneumatic Process Instruments

American Machine & Metals Inc., U. S. Gauge Div., Sellersville, Pa.—12 *page booklet*—Pneumatic instruments for the process industries, described in Catalog 515 include: Pressure and temperature pilots and pneumatic transmitters. Photos

highlight mechanical construction features of both types of instruments. Diagrams show case dimensions and mounting arrangements. Pressure measuring elements described include: Bourdon-tube, helical movement, diaphragm, and bellows types. Mercury vapor and gas and organic-liquid actuated temperature measuring elements are included. Optional indicating controller features covered include: Pneumatic set-point, control by-pass, and valve positioner.

Circle 476 on Page 19

Air & Hydraulic Cylinders

Tomkins-Johnson Co., 2425 W. Michigan Ave., Jackson, Mich.—16 page booklet—Data are contained in Bulletin SQ3-60 on the interchangeable Squair head air cylinders which are capable of producing maximum force with minimum pressure. The cylinders are also adaptable to the use of low pressure oil as the working medium. The data given include bore sizes, rod dimensions, and allowable strokes.

Circle 477 on Page 19

Electrical Connectors

Electrical Products Div., Joy Mfg. Co., 1201 Macklind Ave., St. Louis 10, Mo.—4 page pamphlet—Electrical plug and receptacle connectors outlined in Bulletin B68 are applicable on limit switches, hand tools, small motors, solenoids, and temperature controls. When installed on wiring equipment, they reduce production losses caused by faulted feeders, motors, and control equipment. Details are given on the quick-replacement feature.

Circle 478 on Page 19

Data Processing System

Beckman Inc., Scientific & Process Instruments Div., Technical Information Dept., Fullerton, Calif.—8 page bulletin—Subject of Bulletin S-4017-A is Model 123 Data Processing System whose function is to collect operating data, convert it to meaningful numbers, and make it available for study or for immediate use in process control. Some of the features described include: Pinboard programming, analog-to-digital conversion, and transistorized electronics. A method is outlined for developing a step-by-step program of "building block" process control.

Circle 479 on Page 19

Silicones

Dow Corning Corp., Midland, Mich.—12 page booklet—Bulletin 10-126 contains engineering data and processing information on silicones, with details given on the electrical and mechanical properties of the silicones most useful in electronics. Applications for silicones for use in instruments ranging from computers to servo motors, are described.

Circle 480 on Page 19

Electric Motors

Century Electric Co., 1806 Pine St., St. Louis 3, Mo.—16 page booklet—Application guide (Bulletin 270B) outlines electric motors ranging in size from 1/20 to 400 hp. This includes polyphase, single-phase, and direct current motors. Factors to consider in motor selection are discussed, with numerous motor selection charts given.

Circle 481 on Page 19

Tape Perforator

Soroban Engineering Inc., Box 1717, Melbourne, Fla.—24 page handbook—Subject of booklet is Model GP-2, a tape perforator capable of recording digital data in standard tape at the rate of 300 codes per second. Mechanical components, circuit design considerations, and mechanical and electrical characteristics are described. Theory of operation is explained, and sketches show punch motions, control signals, and recommended punch drive circuits.

Circle 482 on Page 19

Digital Instruments

Non-Linear Systems Inc., Del Mar, Calif.—6 page pamphlet—Data are contained in Bulletin SF-4 on digital voltmeters, ratiometers, ohmmeters, and voltage and resistance comparators. A comparison is made on each digital instrument series by application, features, and specifications. Notes are also given on input accessories such as transistorized scanners and ac/dc converters, and output accessories such as data printers, electric typewriter systems, and transistorized serial converters.

Circle 483 on Page 19

Linear Displacement Transducer

Daytronic Corp., 225 S. Jefferson St., Dayton 2, Ohio—16 page booklet—Miniature transducers described in Catalog 100B are capable of electrical measurement of linear displacement, motion, size, strain, and similar mechanical phenomena. The units have a resolution to 0.5 microinch, with linear ranges to ±0.100 inch. The principle of operation is explained, aided by schematic diagrams.

Circle 484 on Page 19

Silicon Rectifiers

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.—20 page booklet—Silicon rectifier units described in Booklet B-7900 consist of a single rectifier transformer, silicon rectifier cubicle, ac or dc switchgear and regulating equipment, and metering and control items. It is explained how these units meet electrochemical industry power conversion needs that are required for the production of aluminum, copper, chlorine-caustic soda, sodium, and magnesium. Also included is a single-line diagram for electrochemical application.

Circle 485 on Page 19

Plug-in Components

Alden Products Co., 117 N. Main St., Brockton 64, Mass.—20 page booklet—Components used to make up electronic systems are outlined. This includes terminal card mounting components, basic chassis, and basic housing units. Mechanical and electrical accessories such as testing and sensing devices, back connectors, and locking and fastening devices are also covered.

Circle 486 on Page 19

Swivel Joints

OPW-Jordan Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio—12 page booklet—Stainless steel swing joints described in Catalog F-8 can be used for bulk loading or unloading wherever fluids, chemicals, or other products require stainless steel piping and stainless steel swivel joints. Data are given on units in a spring balance style in 2½, 3, and 4-inch sizes and in the counter weight style in 2, 2½, 3, and 4-inch sizes.

Circle 487 on Page 19

Meter-Relay

Assembly Products Inc., 75 Wilson Mills Rd., Chesterland, Ohio—4 page pamphlet—A meter-relay which combines continuous signal indication with control action and instantaneous reset is described in Bulletin S-2-1. Illustrations show how various circuit components are affected at different steps during the operation of the unit. Wiring diagrams are also given.

Circle 488 on Page 19

AC Motors

Sterling Electric Motors Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.—56 page catalog—Data are contained in Catalog 200 on line of ac multishielded motors ranging from ¼ to 200 hp. Various modifications, mountings, and enclosures are described. Charts list load characteristics, load current, and minimum torque and maximum starting current. Information is also given on drip-proof motors.

Circle 489 on Page 19

Universal Test Station

Consolidated Avionics Corp., 800 Shames Dr., Westbury, N. Y.—8 page bulletin—Subject of bulletin is Model 1447A universal test station which automatically tests and calibrates a wide variety of components via taped-coded test programs that result in digital printout and visual readouts. Some of the components that can be tested include: Transistors, tubes, diodes, transformers, transducers, power supplies, voltage regulators, and batteries. A block diagram of the unit is given, as is a typical testing sequence.

Circle 490 on Page 19

Power Supplies

Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.—16 page booklet—Line of dc power supplies described in Catalog E60 includes transistorized power supplies, magnetic amplifier-regulated power supplies, semiregulated units, and filter packs. A list is included of custom power supplies which can be ordered to fit customer specifications. A discussion is also included on the selection of the proper type of power supply.

Circle 491 on Page 19

Permanent Magnet Pulleys

Stearns Magnetic Products, 635 South 28th St., Milwaukee 46, Wis.—6 page pamphlet—Data are contained in Bulletin 1022 on line of Indox V permanent magnet pulleys ranging in size up to 48 inches in diameter. Two types of pulleys are described: A standard duty unit which has a uniform magnetic field depth across the entire width of the pulley face, and a heavy duty unit which has a magnetic field depth which varies with pulley width. A selection chart is given, with an explanation on how the proper diameter can be determined.

Circle 492 on Page 19

Hydraulic Components

Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio—6 page pamphlet—Components designed for hydraulic systems up to 5000 psi are outlined in Bulletin 146-F. This includes pumping units, vane and axial piston fluid motors, flow control valves, check valves, pilot operated pressure control valves, directional control valves, remote control valves, and electrohydraulic pressure control valves.

Circle 493 on Page 19

Synchros & Resolvers

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.—24 page handbook—Test equipment for servo components is described. The electrical characteristics of synchros and resolvers are discussed, with details given on the application and significance of parameters such as electrical error, electrical zero, fundamental null, total null, transformation ratio, and phase shift. Data are also included on electrical error measurement procedures, null measurement procedures, and phase shift and transformation ratios measurement procedures.

Circle 494 on Page 19

3-Way Valves

Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio—12 page booklet—Line of full capacity, 3-way valves for air, oil, water, gas, chemical, or vacuum service is described in Bulletin 91023. The valves are available in size from ¼ to 1-inch, with operating pressure from 0-250 psi. A parts list and ordering information are included.

Circle 495 on Page 19

Motors and Generators

Howell Electric Motors Co., Howell, Mich.—8 page bulletin—Bulletin L-1661A outlines motors and generators manufactured by Howell Electric Motors Co., Ohio Electric Mfg. Co., Kingston-Conley Inc., and Leland Ohio Electric Co. This includes ac motors ranging from 1/40 to 300 hp for applications on cranes, hoists, elevators, machine tools, oil burners, gasoline, and water pumps. Notes are also given on horizontal-shaft and right-angle gearmotors, coupled-unit speed reducers, generators, motor-generators, frequency changers, and industrial bench grinders.

Circle 496 on Page 19

Control Valves

General Kinetics Corp., Dept. C, 197 S. Van Brunt St., Englewood, N. J.—16 page booklet—Data are contained in Catalog GV-101 on line of cast, barstock, and special valves. The valves are supplied in sizes from ¼ to 14 inches, for pressures from high vacuum to 50,000 psi, and temperatures from −425 F to 1800 F. Charts list flow capacity and characteristics, and a series of illustrations show the functioning of a valve as it goes through a cycle of operation.

Circle 497 on Page 19

Shipping Case Sealing Machines

J. L. Ferguson Co., Sales Dept., P. O. Box 1226, Joliet, Ill.—16 page booklet—Data are given in Booklet 100-37A on paperboard shipping case gluing and sealing machines. This includes a compression sealer and a gluer with automatic feed. Typical applications of machine modifications and accessories are described and illustrated. Also described is a machine, designated Packomatic, which is a consecutive serial numberer and date-coder that uses self-inking rolls.

Circle 498 on Page 19

Digital Information System

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—8 page bulletin—Subject of Bulletin E72-2 is Metrotype, a digital information system which uses all solid-state components. Principle of operation is explained, and a block diagram shows the basic elements in the system. Details are given on the indicator-control console, and the types of log sheets that can be used are discussed.

Circle 499 on Page 19

Process Control Systems

Control Systems Div., Daystrom Inc., Miramar Rd., La Jolla, Calif.—12 page booklet—Industrial process control systems are graphically outlined. Some of the subjects covered include: The benefits of a total systems approach, what is meant by single-source responsibility, and the company's guarantee of 99 per cent operational availability. The flexibility of a typical control system is described, and the control-associated functions it will automatically perform are listed.

Circle 500 on Page 19

Mechanical Vibrating Conveyors

Jeffrey Mfg. Co., 956 N. Fourth St., Columbus 16, Ohio—63 page catalog—Four types of mechanical vibrating conveyors are described in Catalog 954. The heavy duty conveyor is designed to handle large capacities under the most severe conditions of service and atmosphere. The twin mass conveyor is a dynamically balanced unit suitable for applications above ground level. The medium duty-medium weight conveyor is for the handling of medium capacities, and the low capacity-low height conveyor is designed for small tonnages. Notes are also given on weigh feeders, dryers, coolers, barrel packers, screens, and magnetic separators.

Circle 501 on Page 19

POST
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Connected to any Post Decitron electronic counter, the new lineal footage device permits accurate length measurement for continuous production items.
Each time the wheel revolves, a photolight beam is broken and a count equal to one foot is registered by the counter. Varied "beam-hole", or wheel size will permit the counting of fractional parts of a lineal foot if desired. Different types of wheels provide traction surfaces for wire, rope, aluminum sheets, bar or flat steel, paper, cloth.
Used in conjunction with a Post Decitron "Preset" counter, (i.e. PW-2) a predetermined length of stock can be measured, and "marked" or cut-off as desired.
Ideal for labels and paper making where footage is most accurate measure of production.
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Circle 702 on Page 19

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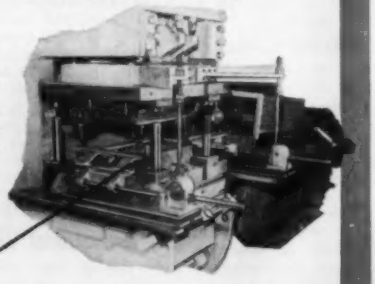
Automation with LIVERNOIS Standard Transfer Units are easily incorporated in new designs to fit large or small presses. Move any part, any distance vertically or horizontally.

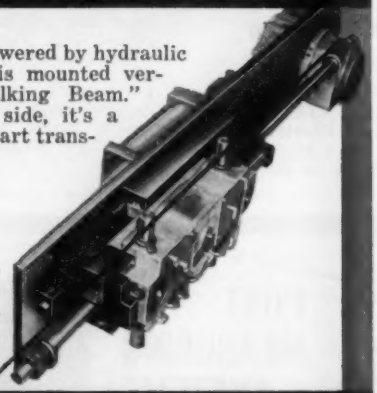
Die changeover is quickly made. Economical even for low volume production on new or existing equipment.



Press application of small 3-station line transfer unit shown.

AUTOMATION

Standard unit powered by hydraulic or air cylinder is mounted vertically for "Walking Beam." Mounted on its side, it's a "Shuttle Type" part transfer unit.



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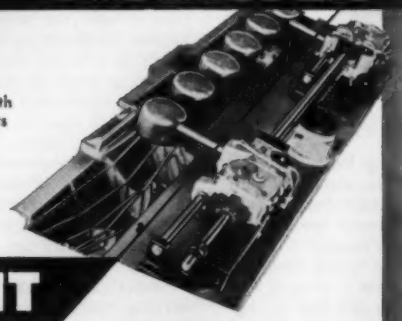

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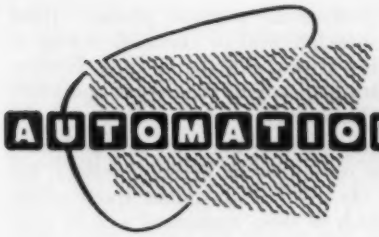


abstracts

NUMERICAL CONTROL IN AUTOMATION

By J. C. KEEBLER
Managing Editor

TO ESTABLISH an organized frame of reference from which developments in automation and numerical control can be discussed, it is appropriate to consider the definitions of each of these terms, some information about their histories, and some types of each.

Certainly technological progress in both automation and numerical control can go forward without resolving the question of differentiation between the two. Engineers can design and apply more highly sophisticated systems of each without giving a thought to whether they are synonymous, or antonymous, or in any way related. Yet with the knowledge of some prior confusion, it seems appropriate that an introduction to automation and numerical control should establish a frame of reference that may enable subsequent material presented to be more readily understood.

When Del Harder first started using the word "automation" the equipment referred to was generally some sort of handling device to move material between presses. In some auto plants today, "automation equipment" still refers primarily to specially-designed handling equipment. However, as Harder's concepts of linking successive pressworking operations into continuous production processes were expanded to encompass other types of production, the word came to include a broader concept of making things automatically.

Now, people concerned with industrial production generally agree that automation may be defined as: *The science of performing manufacturing operations or services as automatically as possible or as the economics of a situation limit or require.* Some say that, given unlimited financial resources, anything can be done automatically. Manufacturers, however, must include economics in their analysis of automation because they cannot afford to do things automatically just for the pride of owning automatic equipment.

Just as this definition is not limited to pressworking, it is also not limited to automobiles, and not limited to metalworking. In a manufacturing engineering sense, no restriction with respect to type of process, type of product, or type of industry need be applied to the definition. Nor is there any reason to restrict it with respect to quantity, lot size, or the manner in which the automatic operation is accomplished.

This broadening of meaning from narrow specifics to general categories was sparked by the realization that the concepts had wide application and that the basic principles involved were valid for all functional and industrial areas of specialization.

Automatic manufacturing techniques had been applied to varying degrees in all industries, and in most instances have roots that predate the use of the term, automation. Yet the broad use of the term placed increasing emphasis on analysis of manufacturing methods and created a realization that, by restudying previous developments in broader terms, basic technology of automation could be documented.

When viewed from this vantage point, Harder's contributions in terms of newly developed equipment for automotive use are overshadowed by his larger contributions in providing a frame of reference through which to study manufacturing engineering, and a concept that makes automation more of an industrial philosophy than a piece of industrial hardware.

All manufacturing can be said to consist of eight basic processing steps:

1. Raw materials handling and processing.
2. Product or component manufacturing.
3. Inspection and quality control.
4. Assembling, combining, or mixing.
5. Performance testing.
6. Packaging.
7. Warehousing and storing.
8. Shipping and distributing.

To attain the most effective automatic processing systems, the equipment that performs these basic steps must be interconnected by automatic handling equipment and interlocked by an automatic control system. To co-ordinate manufacturing processes with other functions of the business enterprise, the processing steps are linked with the order, production control, and business data processing operations of the plant by suitable automatic data handling means.

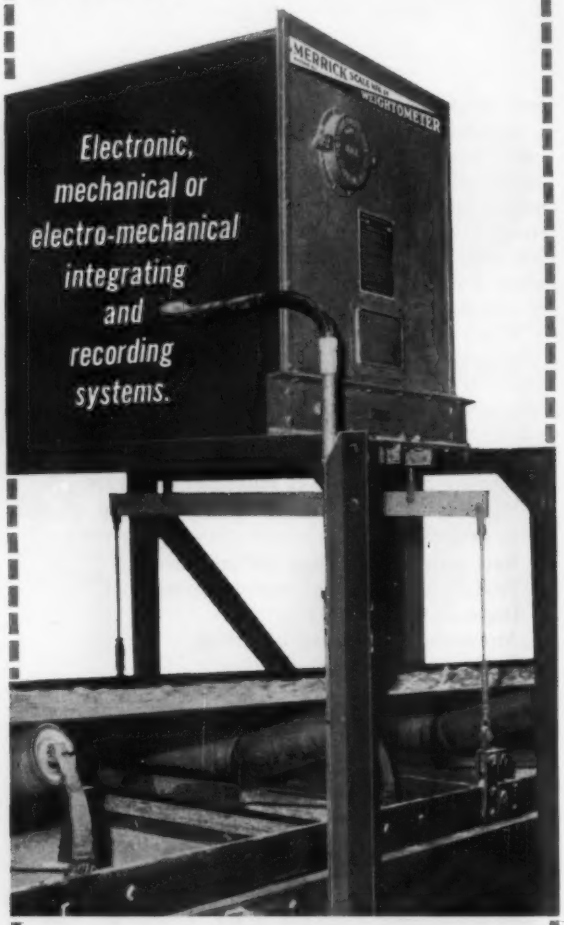
Three-Phase Approach

In considering equipment for automation, it can be seen that three basic phases of emphasis exist: 1. Work-performing processes. 2. Handling. 3. Control. Manufacturing engineers responsible for production techniques must consider each of these phases in specifying manufacturing systems and the equipment necessary to make them work.

It is well to recognize that each of these phases can be considered a specialty in its own right, but that successful manufacturing engineering effort is usually based on a recognition of their interdependence, and therefore considers all of these phases as subdivisions of a comprehensive approach to automation.

Work-Performing Process: Engineering of manufacturing processes requires the determination of a sequence

For continuous accurate weighing of conveyor-carried materials



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of operations to produce the required product. These operations cause some physical or chemical change of the material. It may involve drilling, bending, heating, cleaning, fractionating, or any of the host of operations known to modern technology.

The manufacturing engineer must not only determine a sequence for the operations he deems necessary, but he must also decide upon work-station specifications that determine which of these operations will be combined in a given work station, and what the capacities and rates of each shall be. The degree to which each is to be performed automatically has a marked bearing on these decisions and the known technology for performing them automatically will be reflected in the cost of the facilities of manufacture.

When processes are analyzed on the level of unit operations, techniques of work performance used for one product, or those that are highly developed in one industry, are seen to be applicable on a broad scale to other products and industries.

Handling: Modern manufacturing requires not only that the work be performed automatically, but that the material be moved within, and between work stations in an automatic manner. Handling in this context encompasses all types of manipulation and transportation and is not restricted to specific classes of equipment.

Within a work station the handling requirement might include feeding, escaping, orienting, loading, extracting, chucking, or clamping. Handling between work stations may involve indexing, transferring, storage, stacking, conveying, or trucking. Specific techniques of automatic operation have been broadly applied to each of these. Another classification that has proved useful for study is that of material type as reflected in such terms as web or coil stock handling, bulk or granular material handling, and discrete parts handling. The manufacturing engineer of today is every bit as concerned with handling the material automatically as he is with performing the work automatically

Control: To do these things automatically requires automatic control systems. A work station or a handling device can be made to cycle automatically and can be interlocked with other work stations and handling equipment to perform as an integrated automatic system. Control systems have been classified with respect to the variable being controlled (temperature, flow, pressure, position, speed, etc.) or with respect to the mode of operation (electrical, pneumatic, hydraulic, electronic, mechanical, or combinations and subdivisions of these).

Manufacturing engineers and production equipment designers who specify automatic control systems for manufacturing facilities are interested in choosing the appropriate system to meet the requirements of their work performing and handling cycles.

Numerical Control Defined

Numerical control fits into the third phase of the three-phase approach and is one of the techniques available to the designers and users of automatic production equipment. Therefore manufacturing engineers and production equipment designers must know what

it is, how it works, and when to select it in preference to other types of control systems that might be chosen.

When wartime military needs fostered the development of advanced servo systems the engineers involved in such work began to visualize industrial applications. If computer elements and servos could be linked to control gun-positioning and firing systems, they might also be used to direct the actions of machine tools. The U. S. Air Force was the first organization to put big money into the project. Originally working with Parsons Aircraft and subsequently with the Servo Laboratory at the Massachusetts Institute of Technology the first tape-controlled large-scale contour milling machine was developed. Subsequently, the Air Force let contracts with machine-tool builders to produce about 100 major machine tools that embodied these concepts or variations of them.

Now, people concerned with industrial production equipment generally agree that numerical control may be defined as: *That class of control system that uses numerical data as input control instructions to automatically guide the cycle of a machine.* As with other types of control systems one may subdivide numerical control by what is being controlled (complex contouring, end-point positioning, sequence programming) or by the mode of operation (input media; punched card, punched tape, magnetic tape; presence or absence of computer elements, servos, electronic circuits, feed-back loops, buffer storage or memory elements).

This definition is not limited to contour milling; it is not limited to aircraft parts production; nor is it limited to metalworking. In an equipment design sense no restriction with respect to type of process, type of product, or type of industry need be applied to the definition. Nor is there any reason to restrict it with respect to quantity, lot size, or the type of work-performing process or handling operation to which it is applied.

This broadening of meaning from narrow specifics to general categories foretells widespread application of the technique, but is restrictive in the sense that it describes a class of control systems. Insofar as the three-phase approach to automation makes choices within each of the phases interdependent, use of numerical control has a marked effect on the other two phases, therefore, on the whole manufacturing technology. These effects are within the framework described as automation and do not supplant it with another basic concept to be mastered.

The advantages of controlling automated production equipment with numerical-control systems are many. Certain of the systems can provide for complex contouring that is difficult if not impossible to achieve by other means. A variety of positioning requirements can be accommodated by numerical-control systems. Just as a roll of paper in a player piano can control which note is played when, a roll of tape or a deck of cards in a numerical-control system can control what machine action takes place when. In general, numerical-control systems for positioning and/or programming are less complex than those for contouring.

One characteristic of numerical control that is of particular interest is that, within the design scope of

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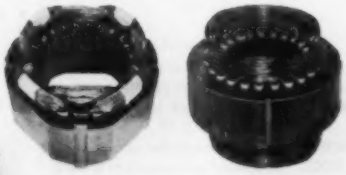
Automatic simultaneous winding of 2 to 5 group concentric coils . . .



*LOWEST MACHINE INVESTMENT PER UNIT PRODUCED.

- Winding speed at 325 RPM
- Preparation time: 4-pole, ¼ minute; 2-pole, ¾ minute.
- One operator can readily tend two or more machines.
- Automatic cutting and anchoring of leads.
- Winds greater range of stator lengths.

* Production example: 4-pole stator with 3-group concentric coil per pole at 125 turns per coil produces 88 stators per hour; 2-pole with 3-group concentric coil per pole at 159 turns produces 58 stators per hour.

a given system and the equipment to which it is applied, the cycle of actions and the limits of actuation can be changed by use of a new tape or deck of cards. This flexibility makes the system advantageous for job-lot production. The quick changeover feature means large savings in setup costs for manufacturers of products that are similar in nature but which come in a variety of shapes and sizes.

Caution against too restrictive categorizing of applicability of techniques is a wise policy. It may not be appropriate to use a numerical-control system on a transfer machine designed solely for one model of automotive-engine block. Other control systems may perform adequately for less cost. However, as transfer-machine design trends toward building-block construction for flexibility of workpiece redesign, the flexibility feature of numerical-control systems might find a natural application in unitized control of multi-purpose building blocks.

Manufacturing engineers studying their problems on the basis of the three-phase approach to automation equipment are certain to be alert to such possibilities. As a part of automation technology, numerical control is finding wide acceptance, in various industries, where the attributes of such systems fit the requirements of the control problems.

From a paper entitled "Introduction to—Automation —Numerical Control" presented at the Twenty-eighth Annual Meeting of the American Society of Tool and Manufacturing Engineers, Detroit, April, 1960.

PUMP STANDARDIZATION . . . A USER'S CONCEPT

By R. G. JOBE
Shell Chemical Corp.
Houston, Texas

SINCE the centrifugal pump is one of the widely used items of equipment in the chemical industry, considerable incentive exists for standardizing this equipment and, in fact, an industry-wide standardization program is in progress. In considering the adoption of a standard pump for our plant, we made a plant-wide study covering approximately 650 centrifugal-pump installations to determine the range of head and capacity requirements, and to obtain cost data to serve as the basis for selecting the optimum standard design.

To establish the range of head and capacity required, the design points for all existing pumps were plotted on one head-capacity chart for comparison. Analysis of the distribution of these points led to the conclusion that the standard pump should be capable of developing a shut-off head of at least 200 ft and a differential head of 120 ft at a capacity of 250 gpm. A pump meeting these requirements would handle approximately 80 per cent of the centrifugal-pump applications in our plant. In order to have a compact pump practical for lower-capacity applications, it was decided that performance beyond these limits should be handled by a larger pump.

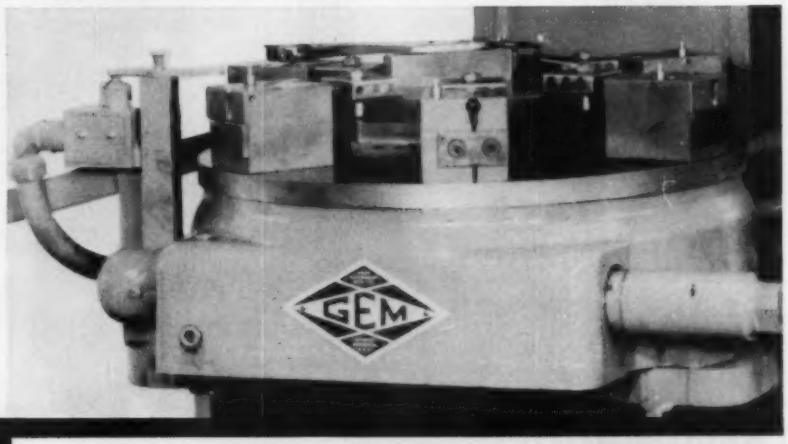
The basic economic consideration was the lowest over-all cost for the life of the pump. We were seek-

precision indexing to ±0.001"

. . . WITH GEM-17 DIAL INDEX TABLE!

FAST	Geneva motion smoothly positions in speeds up to ½ sec.
RUGGED	1000 lb. work load with solid anvil capacity of 30 tons.
POSITIVE LOCK	Bolt in Geneva slot cammed both in and out given positive locking.
POWER	Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).
NUMBER OF STATIONS	6, 8 or 12 standard, 3 and 4 skip.
SIZE AND WEIGHT	200 lbs. complete with 17" dia. table (plates up to 36" available).

GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.



Geneva Motion GEM-17 Indexing Table standardizes automation on your assembly and machining operation . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

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Circle 707 on Page 19

ing a unit which would provide an economic balance between the first cost of purchase and installation and the continuing cost of operation and maintenance.

Comparison of continuing costs with capital cost showed that, on the average, during the life of the pump the sum of the continuing costs (maintenance, power, oil, etc.) would exceed the capital cost by several hundred per cent. This indicated that the standard design should emphasize reduction of the continuing costs. This does not mean that capital costs were to be disregarded, but rather that maintenance cost-reduction features would be favored where compromises would be required.

Further analysis showed that maintenance costs were among the most important factors contributing to the continuing costs. It was apparent that maintenance-cost reduction should be one of the primary objectives. Further study led us to conclude that: 1. The standard pump should be designed so that it could be quickly removed from service for shop repairs. 2. The pump should be simple to dismantle and reassemble in the shop. 3. The pump should be designed to use a minimum number of component parts.

Because of the relatively small size of our pumps and the unfavorable conditions in the field, it is our practice to make repairs in the shop; hence, the installation and removal steps are an integral part of the maintenance procedure. Ease of dismantling under shop conditions and the reduction in the number of parts are features which would be expected to reduce cost of repair parts and further reduce maintenance labor costs.

All features of the standard pump were expected to be consistent with the basic requirements of dimensional interchangeability, reliability, and moderate first cost.

Evaluation of the over-all economics and performance requirements resulted in establishing the following criteria:

1. The pump should be capable of providing sufficient capacity to meet the performance requirements for at least 80 per cent of the centrifugal pumps in the plant.
2. It must feature maximum dimensional interchangeability both in mounting dimensions and pump parts.
3. It must be simple to remove and install.
4. It should use a minimum number of parts.
5. It must be simple to dismantle and repair under shop conditions.
6. The installed cost should be as low as possible, consistent with maintenance requirements and reliability.

The implications of these requirements were discussed in detail with the engineers from United Centrifugal Pumps. It was the consensus that existing conventional pump designs did not meet these requirements, and it was agreed that a new pump would be developed as the joint effort of United Centrifugal Pumps and Shell Chemical Corp.

The pump which evolved is a vertical centrifugal pump with an integral electric drive. The pump case is designed to withstand piping stresses so that the pump may be installed without a baseplate or concrete foundation.

Since the drivers are integral with the pumps, we have equipped all of the standard units with a plug-

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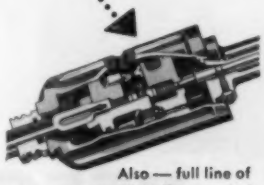

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Circle 708 on Page 19

type electric power and grounding connection to facilitate quick removal. A safety interlock is provided to turn off the power in case the plug is removed when the circuit is "hot." All motors use 3-phase electric power and are connected in the shop so as to have a standard phase rotation. All outlets are corrected to this phasing as they are installed, so that replacement pumps will always rotate in proper direction without the need for field checks.

The seven major parts of the pump are the case, the cover, the impeller, the shaft, the mechanical seal, the sleeve, and the orifice. A common shaft is used for both pump and motor. The shaft is protected from the process fluid by the impeller, the impeller nut, and the sleeve. This protection permits interchangeability of drivers between alloy and carbon-steel pumps.

Since the pump was designed for use under shop repair procedures, the advantages of close-coupled design could be realized without increasing maintenance costs due to limited accessibility. Close-coupled design results in reducing the number of parts and improves ease of dismantling by eliminating the pump bearing, the bearing bracket, the lubricator, the shaft coupling, and the coupling guard, all of which are found on the conventional horizontal chemical plant pump. In addition, the integral design results in a more rigid shaft than would be possible for a coupled shaft design of the same diameter. This permits the use of a smaller mechanical seal.

Since alloy construction is sometimes required for pumps in chemical plant service, this pump was designed for ease of casting so that it could be economically built in any castable alloy. The shaft is fully protected by the wetted parts so that special motors with alloy shafts will not be required for alloy pumps.

Although the new design has only recently emerged from the development stage, some indications as to the effect of the design on plant pump cost have resulted from our experience in the field. Comparison of the installed costs for the eleven test units with similar costs for conventional medium-duty horizontal centrifugal pumps in these services shows that installed costs (including the price of the pump) were reduced 20 to 35 per cent below that of conventional pumps of cast-steel construction. These savings are due largely to the elimination of concrete foundations and the elimination of the shaft coupling with its alignment problems.

In the congested process areas of existing plants the compact design permits the standard pump to be installed without undue extension of piping or blocking of accessibility to existing equipment. In new construction we believe that further savings especially in piping costs could be made by judicious mounting of pumps on major equipment or on pipeways as is done with motor valves.

From a paper entitled "Pump Standardization . . . A User's Concept," presented at the Annual Meeting, American Society of Mechanical Engineers, Atlantic City, N. J., December, 1959.

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Circle 710 on Page 19

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Circle 712 on Page 19

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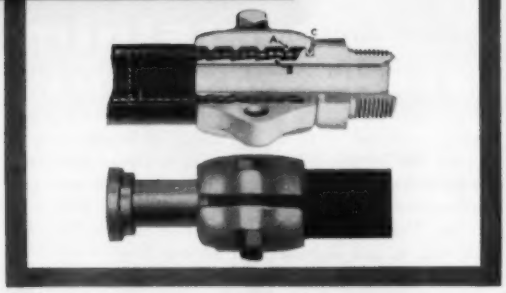

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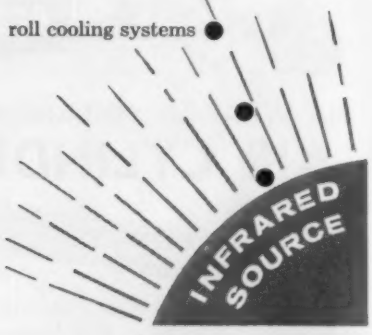

WHAT'S YOUR PROBLEM?

Write for Bulletin E-300

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Circle 714 on Page 19

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2026-P

PIPE LABELING

. . . We manufacture exhaust and tail pipes. As a final operation we place a label around the pipe by manually pushing it through a labeling mechanism. We would like to upgrade this manual operation. If the labeling is applied before the bending operation it becomes excessively dirty; the shape of the pipe after bending prevents the pipe being rolled over a label . . .

Manager

CASE 2170-P

LOADING SMALL DRILLS

. . . We request information on loading small drills (0.060 inch in diameter and smaller) properly oriented to a centerless grinder. Any information will be appreciated relative to delivering parts of a small-drill nature to a machine for subsequent operations . . .

Vice President

CASE 2024-P

INDEXING DEVICE

. . . I am designing an inline transfer machine for processing of 20-gage galvanized steel plates of various lengths. The plates are prepunched with a standard hole pattern into which nails are to be fed by means of hopper feeders. The plates will contain piloting dimples to insure accurate alignment of holes to feeding equipment. I would like to receive information on an accurate indexing drive with a 2-inch stroke. The system is to accommodate four widths of plates (3, 4¼, 6, and 7 inches) in various lengths . . .

Engineer

CASE 2027-P

CAM CONTROLLED INDEXING

. . . We are interested in obtaining a work table for positioning a 6 by 30-inch part in an assembly operation. The part is to be indexed to various positions as a cam presses plastic parts into punched holes. Is there an indexing table on the market that can be programmed by a rotating cam to actuate a series of switches that would control the table? . . .

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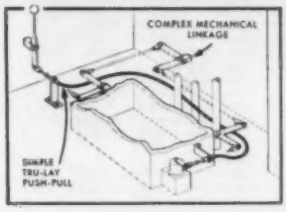
TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



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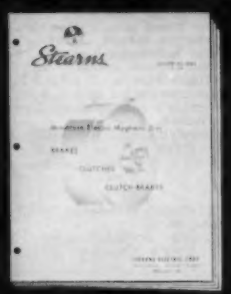
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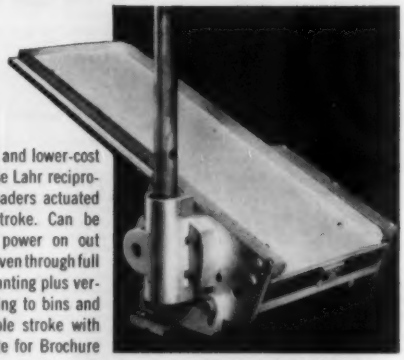
NEW
PART UNLOADERS REDUCE HANDLING



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20-CT-59	10" to 36"	10" to 30"	Cable	AirCycle
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30-CT-59	10" to 72"	12" to 30"	Cable	AirCycle

Special tray widths and strokes available

Lahr MACHINE & TOOL CORP.
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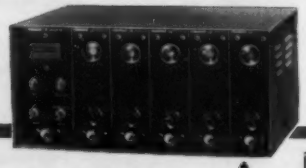
PREDETERMINING COUNTER

Standard 2-decade model:
$245.00



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AUTOMATION

new books

TOOL ENGINEER'S HANDBOOK

Edited by Frank W. Wilson, editor, and Philip D. Harvey, assistant editor; 2289 pages, 6 by 9 inches, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; $19.50.

The second edition was revised under supervision of National Technical Publications Committee, American Society of Tool Engineers. Over 380 authorities from various industries contributed to this updated version. The handbook is concerned with all phases of tool engineering function involved in mechanical processing of products.

ENGINEERING DATA PROCESSING SYSTEM DESIGN

By A. D. Even, management consultant; 282 pages, 6 by 9 inches, published by D. Van Nostrand Co. Inc., Princeton, New Jersey; available from AUTOMATION; $6.50.

Many industrial organizations, in particular those dealing extensively with government agencies, have of necessity sought improvements in the handling of engineering type information. The author discusses the thinking, equipment, and systems which are an outgrowth of the need for improvements. Activities concerned with preparation of engineering drawings, parts lists, and allied documents and records are covered in detail.

ELECTRICAL EFFICIENCY IN INDUSTRIAL PLANTS

By E. S. Lincoln, consulting engineer; 235 pages, 6 by 9 inches, published by F. W. Dodge Corp., New York; available from AUTOMATION; $9.50.

Various factors which contribute to needlessly high power costs, to interrupted production, and to damaged equipment are examined in a practical and readable manner. Included in the subjects covered are: Power system circuits; power factor correction; conducting and analyzing electrical surveys; and safety, inspection, and maintenance considerations.

MANUAL OF MACHINABILITY AND TOOL EVALUATION

By Antoni Niedzwiedzki, machining consultant, Machinability Laboratory, Metallurgical Products Dept., General Electric Co.; spiral-bound, 97 pages, 6 by 9 inches, published by Huebner Publications Inc., Cleveland; available from AUTOMATION; $6.00.

Based upon his machining experience in both Europe and the United States, the author discusses both practical and theoretical considerations of metal cutting and cutting tool design in the turning of steel with carbide tools. In the author's words, "In general, American readers will find this text a survey of European developments which are unknown to them because of linguistic barriers . . . ."

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an exciting editorial section which will report today's progress and predict the future potentials of numerical controls in industry.

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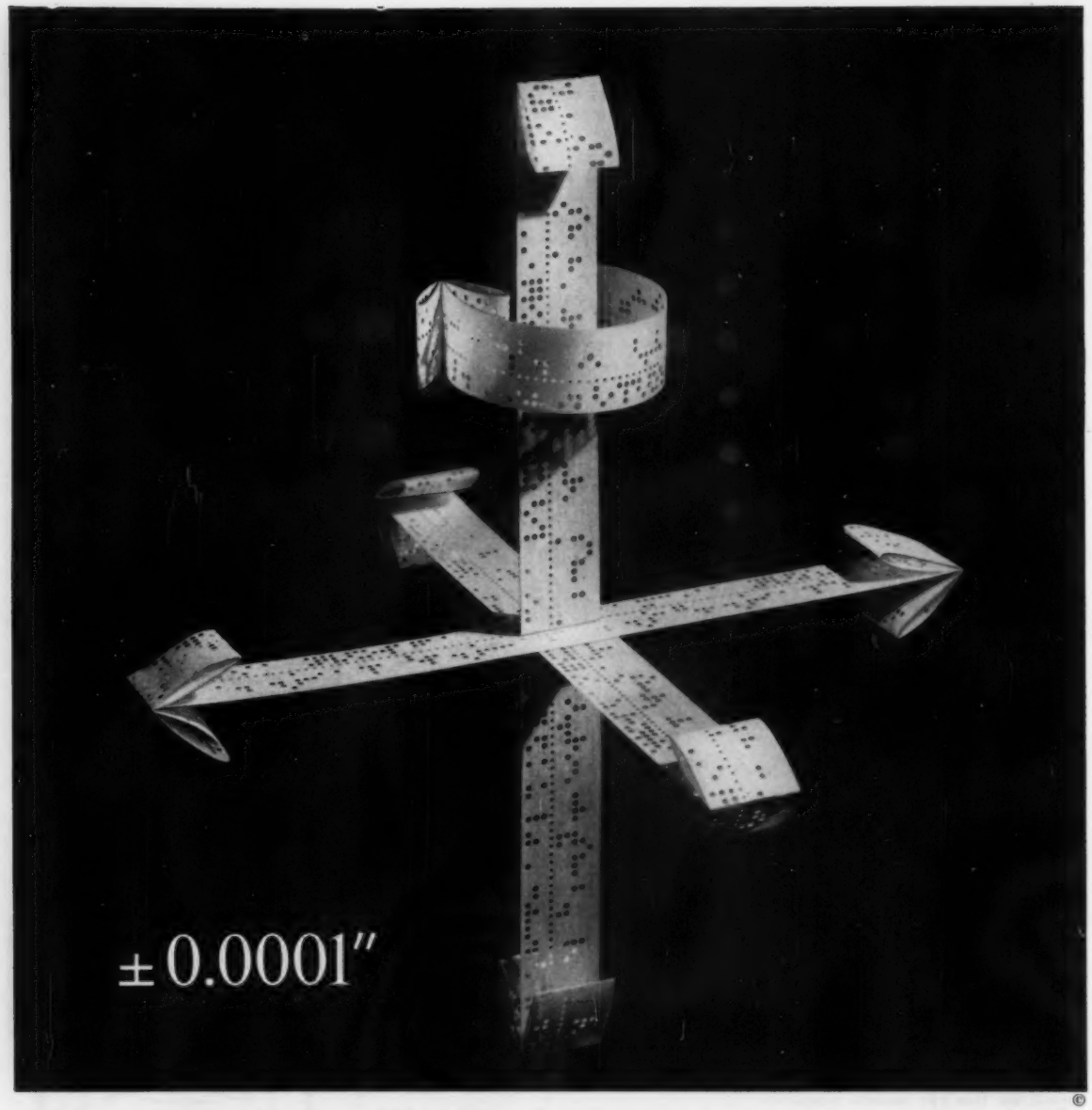

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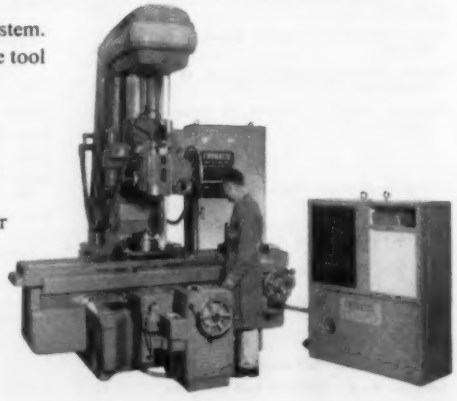

FOSDICK THE FOSDICK MACHINE TOOL COMPANY
Cincinnati 23, Ohio

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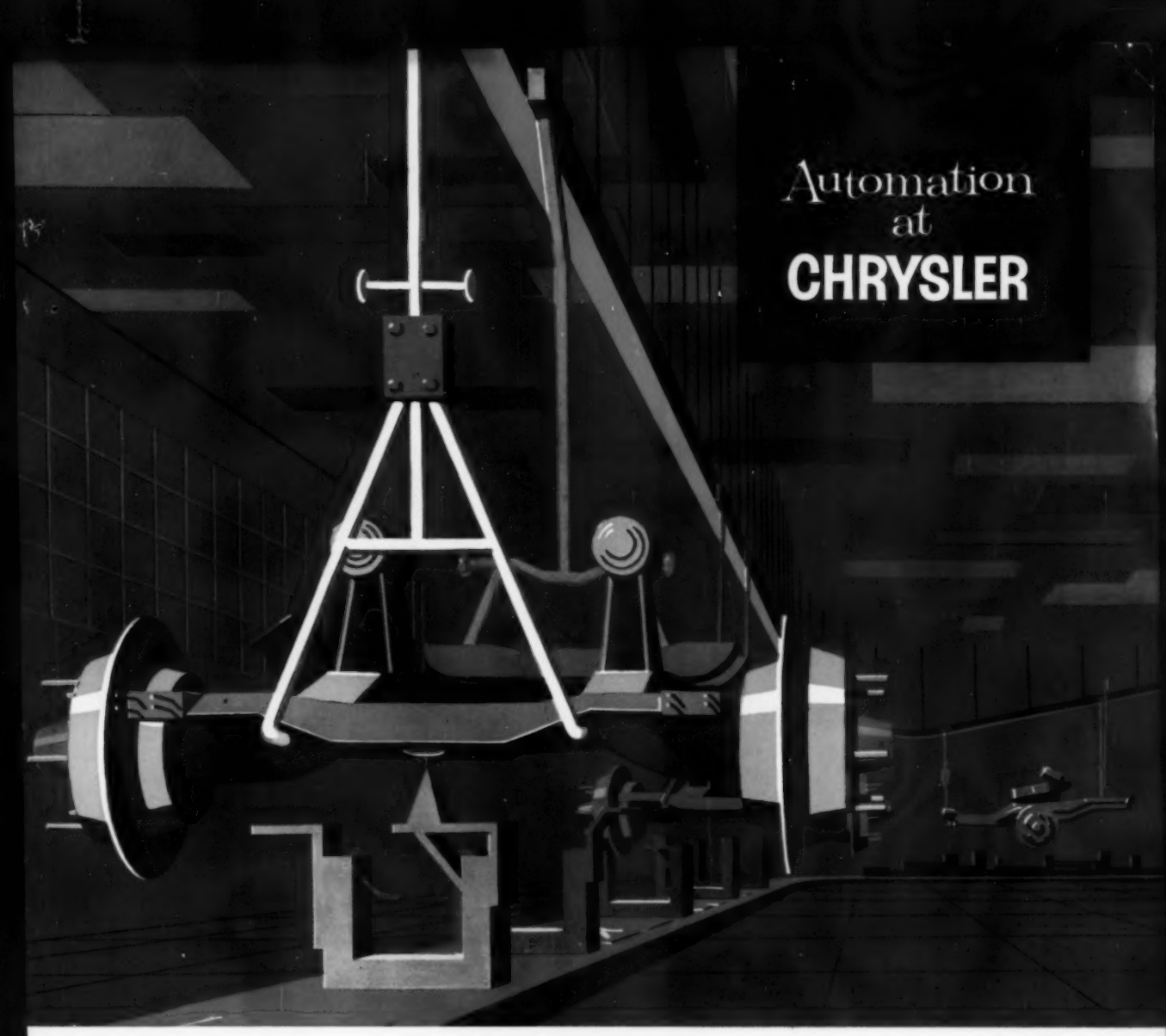

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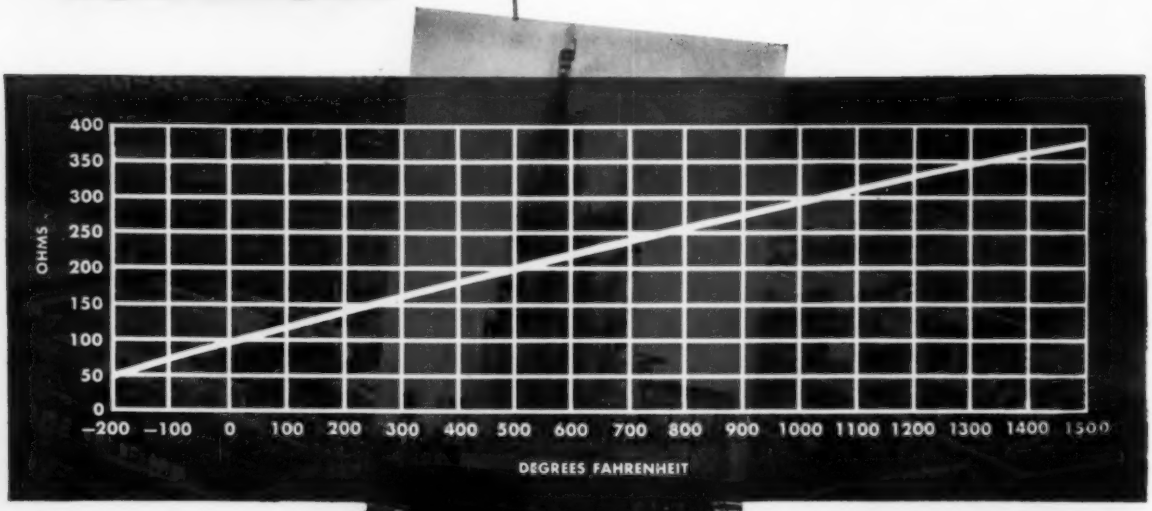
WHEN IT IS VITAL* TO KNOW



T/R Characteristics of Model 242P
Edison Resistance Temperature Detector

THE PRECISE TEMPERATURE

New manufacturing methods and new materials now enable Edison to offer a wide variety of Resistance Temperature Detectors for virtually any industrial temperature measurement. Edison RTDs indicate, record or control temperatures precisely and quickly, over a long period of years — without drifting, without maintenance and without errors due to ambient temperatures, stray elecrical fields, nuclear radiation, shock or vibration.

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Standard detectors are available for use in the bearings of all types of machinery, to measure temperatures under nuclear radiation, on air compressors or in any chemical or petrochemical process. A wide variety of detectors for special purposes and for measurements to 1,800°F is also available from Edison, leader in the field.

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